November 25, 1926

Engineering News-Record

Four-Drill Rig on Pioneer Heading of Cascade Tunnel

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ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

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Crowded Programs

EDITORS of technical papers are possibly not proper judges of what constitutes a good program for a technical meeting. It is a part of their duty to attend all the meetings in their field, whereas the individual practitioner attends only a few. What would appeal to the man who goes to three meetings a year may not, therefore, be appealing to the editor who goes to thirty —and not only grows a little weary of much talk but also hears much repetition of the same talk. With those reservations clearly in mind it is worth while to protest against the practice of crowding all technical meeting programs with an undigestible mass of papers. The program maker is always confronted with the alternative of providing a few speakers and papers and facing the possibility of a lack of discussion which will leave empty hours toward the end of each session or of massing enough papers to fill the given time. He always—or nearly always—so fears the first possibility that he resorts to the second alternative, with the inevitable consequence that in the haste to overtake the schedule delayed by some tedious speaker discussion is cropped short or denied altogether and the meeting becomes merely a dreary repetition of scheduled written remarks. How often does the engineer say that he goes to a convention to meet other engineers and to discuss mutually interesting problems with them and how often does he have to do that thing at meals or in lobbies rather than on the floor. Discussion is the life of a technical meeting, and the orderly recitation of an individual view—*in extenso*—is its ruin. Those who have the making of programs to do should remember past performances and once in a while, at least, try a reform.

Inspired Workmen

WHILE few rock tunnels, even in recent years, have called more fully upon mechanical aids to fast work than does the New Cascade Tunnel described in this issue, it is of high significance to note that it is the inspiration of the working force which is making remarkable speed records possible. In this lies a great accomplishment in construction management. It is now, indeed, the era of machinery in construction, but with the most cunning adaptation of machinery there must be men to cherish and direct that machinery so that it works most efficiently. They were developed on the Cascade tunnel work. The means are worth noting. There was subdivision of duties, educational supervision, co-ordination of work, development of standard performance, increased reward for increased performance, prompt payment of reward and the creation of competition. Not a single one of all these devices or agencies for encouraging and inspiring workmen is new. Some or all of them are consciously or unconsciously employed on every construction operation. At the Cascade tunnel operation they are employed consciously and purposefully. As is always the case where this is done, the results are profitable. The article tells the story and it need not be repeated. But it cannot be re-asserted too often that the management of men in all its intricacies is as profitable a study today with many construction machines as it ever was in the past with few machines.

More Light on Rivet Action

TESTS of riveted joints just reported for the U. S. Navy by Commander E. L. Gayhart, of the Construction Corps, add to our knowledge of the resistance of riveted joints without exhausting the subject. Their distinguishing feature is that they were made on very large specimens, tension joints 22 in. wide with ultimate strengths in the neighborhood of 1,000,000 lb. They confirm strongly what practice as well as small-scale testing has previously established, namely, that riveted joints have a remarkable degree of efficiency and dependability. They also show that nothing is to be gained by using rivets of high-strength steel, even when the plates joined are made of such steel. Beyond this, the tests lay renewed stress on the matter of slip, specially in service where tightness is a primary requisite, as in ship construction. Perhaps they would have emphasized the importance of slip also in structural connections if variable or alternating stress had been used in the tests, but unfortunately this interesting feature was omitted from the ambitious program although stress variation or reversal is nowhere so characteristic as in the structure of a ship. Of the other details of the tests, one that invites special attention is the finding that the joints had higher tensile efficiency than shearing efficiency, which leads to the conclusion that it is profitable to increase rivet areas somewhat if the greatest ultimate strength is to be secured. Even with these valuable indications, however, we are by no means at the end of our knowledge of riveted joints, or at the end of need for such knowledge. Dependable and excellent as it is, the rivet will bear a good deal of further exploration.

Division of Labor at Sewage-Works

FUNDAMENTAL data on the everyday working results of sewage-works are being amassed at a few of the best managed plants but at most of them few comprehensive analyses are systematically made, tabulated and digested. The Baltimore works are among the few. The records there now cover a dozen years, during which period the volume of sewage has increased from 18 to 55 m.g.d. No other American city of some three-quarter million population treats all its sewage and few of that size in the world, if indeed any at all, are treating a sewage which is wholly domestic. These facts make the Baltimore studies unique, and also adds to their value to most American cities having sewage-works, because as a rule our sewage-works treat domes-

tic sewage rather than sewage and storm water combined. To the several studies of Baltimore results already published in this journal there is added in this issue one of the bio-oxygen demand. For the raw sewage and for the relation between bio-oxygen demand and nitrate production in the trickling filters the studies cover 13 years, while for the relative work done by the various elements of the plant lesser but sufficient periods are covered. Added value is given by inserting data for the eleven sewage-works investigated a few years ago by the United States Public Health Service. As to final summaries, it needs only to be said here that while the trickling filters effect a much higher percentage reduction in bio-oxygen demand than settling tanks, as would be expected, yet the latter do no inconsiderable amount of work, while the humus or final settling tanks are of relatively little value in this particular.

Big Road Mixers

VARIATIONS from the standard paving mixer is nowadays so uncommon in concrete road construction that attention is attracted to the North Carolina operation on which is employed, as described in this issue, a twin-mixer plant with correspondingly enlarged hauling and placing equipment. A few years ago such special road building plants were of common occurrence. In few instances did any one of them persist beyond a single working season. As paving mixers developed into the larger 21 and 28-cu.ft. sizes it was found that they provided all the mixing capacity that could be used economically the season through with the ordinary accomplishment in materials delivery, batch supply, form setting, placing and finishing. In brief the nub of the task of large output was discovered to be servicing the mixer and not mixer capacity. The theory of the large-capacity plant of course is that by more equipment and superior direction the ordinary accomplishment in servicing the mixer can be increased to utilize its extra capacity. The manner in which this large volume service has worked out on the North Carolina operation is described in the article. To be noted particularly are the difficulties of service as the volume increases. Again to be noted are the complications of handling the larger and heavier equipment units. A two-mile a week concrete road building outfit demands superintendence and foremanship of an ability and experience beyond that commonly available. Keeping this truth in mind the North Carolina operation is an interesting study.

"Building" not "Construction"

IN the heightening appreciation of the meaning of statistics there is developing a whole new industry of prognosticating. Once this guessing as to the future of business was confined to a few, who sold their prophecies and confined them largely to those factors that promised effects on the securities in which men speculate—or invest. Nowadays there is hardly a bank or a newspaper that does not sum up every so often the state of business in the nation and from that state make a guess as to the progress that business will take. Now in these summings up one always finds a reference to the conditions in "building," because it has been pretty effectually demonstrated that the providing of new shelter for man and industry is a good index of both existing financial resources and prospective demands. One thing, however, is too often missed, and that is that there is a distinction between mere housing and between real construction and unless that distinction is recognized some wrong conclusions may be drawn. At present, for instance, there are signs of a falling off in prospective housing and in those forms of speculative building which have run rampant in our larger cities. There is, on the contrary, no sign whatever of a falling off in major construction of the type described in this journal and reported in our Construction News. Prognosticators, therefore, may find something disturbing in the prospects of a diminution of ordinary building which may reflect certain major economic changes, but those who are concerned mainly in the production of that which is ordinarily called an engineering structure need not feel that these same signs indicate any change in the demand for that kind of construction. "Construction" may be going to diminish next year but there are no pronounced indications thereof as yet.

Increasing Subway Costs

UNLESS Justice Levy's ruling in the matter of the "prevailing wage" clause in the New York subway contracts is overturned in the higher court, it looks as though the workability of that clause will have to await a specific controversy under its provisions. The court in its lengthy decision discussed only generalities, that is, the essential propriety of "prevailing wage" and arbitration provisions, and their constitutionality. With the usual caution of courts, it refused to consider possibilities of disagreement under the law. When such disagreement takes place, as it inevitably will if the new contract is enforced, there may be opportunity for the contractor to get before a court the unfairness of the attempting to set up for so specialized a series of processes as those involved in subway building standards of craftsmanship from which prevailing wage scales can be established. A new court, then, with the specific case before it, may not find so simple as does the present one the problem of the prevailing wage. Meanwhile, the court to the contrary notwithstanding, the bids on the new subway contracts will go up to take care of the unknown costs that prospective interference of labor agitation will be bound to impose.

Good Construction Practice

A MORAL lesson can be found in the gradually unfolding facts of the September hurricane in southern Florida. Studies and reports by various interests, mainly those representing different materials of construction used in the storm area, are bringing together bit by bit a more complete picture of the detail facts of storm damage than could be obtained in the first rapid surveys. Because of this fuller detail, the reports are of remarkable value in confirming the first impression that good construction practice made a highly gratifying showing in the storm. Well built structures in the main survived, while—again with exceptions—the poorly built structures were overthrown or shattered. On analysis, moreover, the defects that appear to have been responsible for the wrecking of this or that structure were such as would have been classed as defects or bad construction by the ordinary dictates of good construction practice. But let it be noted that those principles of craftsmanship which constitute "good construction practice" were not evolved from study of the demands

of great emergencies like the recent hurricane, but are the gradual assembled empirical consensus of deductions from day-by-day service. Yet these same construction practices have now proved their superiority also in the unparalleled trial of hurricane force. We thus learn that the type of work which gives us best day-by-day service, the lowest maintenance cost and the highest durability, also exhibits the greatest resistance under extreme stress of storm. It follows that whoever builds a house will benefit doubly by using good construction: not only through better service and greater permanence, but also through greater safety in extraordinary visitations. And, on the other hand, inadequate construction involves a double penalty in the poorer daily service and the added risk of destruction under the stress of some unusual event.

Cement Imports and the Cement Standard

ONE of the first evidences of the industrial recovery of Europe may be found in the increasing importation into this country of competitive goods. So far these importations have been mainly in the less complicated materials, for even with the lower labor costs abroad they are not able to match the factory refinements and production economies which make American manufacturing supreme, but it is apparently possible for the European producer of the grosser manufactured products, such as cement, iron pipe and structural steel, to put down those products on our coasts at a price sufficiently below that possible to the American manufacturer to make them attractive to the purchaser. Part of this possibility lies in the lower producing costs abroad, for which the reasons are obvious, and part to the fact that these goods can be carried in ballast at extremely low ocean freight rates. But whatever the cause the competition, in the coast line areas which constitute a large part of the consuming district of this country, has become great enough to cause worry among the American manufacturers.

The problem here imposed is not the common-enough one of protection versus free trade, for that historic American economic controversy assumes a country-wide distribution of the imported product and a serious dislocation of country-wide production. In the present instance the importations are fairly negligible in proportion to total domestic production and the area of economic competition quite limited. However great the totals of foreign purchase they cannot affect the total American output to a degree which will concern all producers, for domestic freight rates in these heavy materials are governing and the affected American producers are only those whose plants lie near the seaboard.

Nevertheless, since modern industry, especially in this country, is becoming more and more cohesive, the producers of materials affected by this competition are putting up a solid front of agitation against these foreign inroads which, for the time, affect only a part of the industry, this agitation, for the most part, taking the form of demands for some sort of tariff increases which will overcome the foreign differential. Under our present law such increases, to a degree, are in the hands of the President, acting with the advice of the Tariff Commission, so it is to the President that such demands are being made.

The latest of these has just been made by some cement manufacturers. The plea, noted in these columns last week, does not take the traditional form of claiming the destruction of an American industry, for the cement people recognize that no such serious contingency is imminent, but is rather put on the ground that a great amount of money—$29,000,000 in the last six years—is going out of the country for foreign cement, and to balance that is a saving of perhaps one-tenth that amount to the purchasers. To keep this money in the country, to the benefit of Americans working in the cement mills, the railroads, the oil fields and the bag factories and of other Americans holding the securities of these enterprises, is held to be a patriotic necessity.

We do not propose to discuss the economic theory here involved, because its ramifications are too great, though we might suggest that the prospect of an entirely self-contained United States and a likewise self-contained Europe presents some difficulties in the payment of the huge sums that the latter owes the former. We do think it worth while to point out, however, that the difficulties that the cement manufacturers find themselves in just now are in a degree due to the theory of selling that they set up many years ago.

That theory is that there is a simple and ascertainable standard of quality in portland cement, and that all cements which by test equal that standard are equal in desirability and should bring the same price regardless of the degree of superiority they display in such test. On that theory the whole cement industry is based, on that theory it justifies its uniformity of price. Meanwhile it is quite obvious to many users of cement—and to all the manufacturers—first, that the test is by no means the accurate measure of quality that it purports to be and second, that there are many desirable qualities in cement which make its worth increase as these qualities increase, and third, the first two facts being accepted, that the reliability of the manufacturer, his readiness to serve, the reputation of his product in service in the structure, all are of as much if not more importance as a selling argument than the passing of an arbitrary test.

But the manufacturers have hammered home so thoroughly the theory that all cements that pass the standard are alike, that the foreign producer has only to show that his cement, by the infallible test, is just as good as any American and the purchaser, having been educated to a standard product, naturally accepts the saving that is offered him. Service, reliability, excess quality, all the intangibles that make possible the marketing of a competitive product, are thrown into the discard in the worship of the standard. Doubtless so far as domestic selling is concerned this worship has been justified in the results, but it is reaping an unexpected harvest in the competition of the foreign producer. And because it is, there are bound to arise some questionings as to the propriety of the policy in domestic marketing. Such questionings may be stilled for a time by the imposition of a tariff that will exclude the foreigner, but for how long? They may even be postponed by a sufficient awakening of patriotic fervor to overcome the selfish advantage to be gained by a lowered price, though history and a knowledge of human nature show that to be a rather slender reed on which to lean. But in the long run the other question remains. Will superior quality and superior merchandising in cement always have to bow down to the idol of the minimum standard?

Methods and Progress in Driving the 8-Mile Great Northern Tunnel in the Cascades

Pioneer Bore Used on Section 5.37 Miles Long — Power Shovels Muck Full Face Drifts — World's Drifting Record Broken—October Advance 1,157 Ft. in 8x9-Ft. Drift

FOR the third time the Great Northern R.R. is building through the summit of the Cascades in western Washington. The first location—the one that climbed by switchbacks to the summit of Stevens Pass—was replaced by the 2.63-mile Cascade tunnel in 1900 and now the line is being once more improved by the 8-mile "new Cascade tunnel" that makes further savings in elevation, curvature, mileage and grade. When final decision was reached last fall to go ahead with this project all haste was made to get the new line ready for service with as short a construction period as possible. Hence speed was made a primary objective in planning the method of attack and in working out the construction details. When completed this new bore will be the longest railroad tunnel in the western hemisphere and the third longest in the world.

Although the project is still in its early stages the world's drifting record has been broken several times and still better records are expected. The chief factors in this speed are undoubtedly the interest the men take in their work and the effective manner in which the project was planned and equipped. Job interest is encouraged by the bonus system and it has been enhanced by a friendly but none the less intense rivalry of crews at opposite headings using different methods of attack. It is notable that throughout the work there is a spirit of loyalty among the men on this job not unlike that manifest in a good athletic team. In this article attention is given particularly to construction methods and to the experience thus far with ways and means of saving time or cost. A review of progress on the work up to May 31 was published in *Engineering News-Record*, July 15, 1926, p. 100, and announcement of the record drifting record appeared Oct. 7, p. 594. The progress table on p. 863 shows a September advance of 954 ft. in 10x10-ft. drift; the October advance record was 1,157 ft. in 8x9-ft. drift.

The use of the pioneer bore plan of driving from multiple headings was adopted when it developed that the Mill Creek shaft would be the only economical means of access to the line between portals. This shaft divides the tunnel into two sections, 5.37 and 2.41 miles long, respectively. The longer of these sections, being the limiting factor in the completion of the project, is being attacked at both ends by the pioneer method which, with crosscuts every 1,500 ft., will make it possible to keep the center headings well in advance of the work of enlarging to full tunnel section as this is advanced from both ends. On the shorter section no pioneer is necessary as the center heading west from the cast portal will join the center east from the shaft in ample time to permit the stoping out to the full tunnel section in one enlarging operation.

The pioneer provides several working faces from which the center heading can be advanced and enables drill crews working on enlargement of the completed center heading to come and go without interfering with mucking operations in the main tunnel. Thus the pioneer, connected by crosscuts with the center heading, makes it possible to do all the drilling for enlargement ahead of the shovel and free from any interference with it.

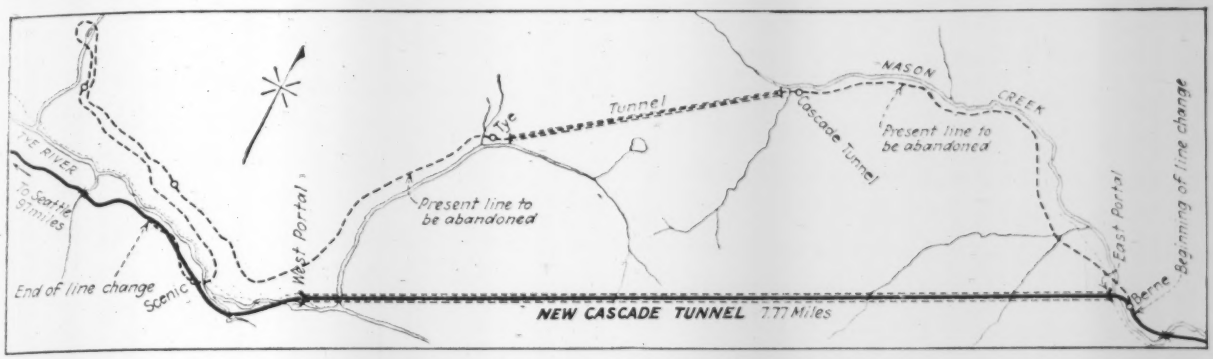
The Tye River incline on a 30-deg. slope to the pioneer bore near the west portal was an expedient to get the

TYPICAL CAMP VIEW AT WEST PORTAL
Walkways were to be housed over before winter. Mess hall at left.

benefit of the pioneer plan in a shorter time than that required to advance the pioneer heading at grade as far as the incline. About 1,500 ft. of soft ground at the portal slowed up progress in this pioneer heading and by the time the pioneer heading crew working in from the portal finally broke through at the incline, an advance of 3,424 ft. had been made from the incline and two crosscuts to the center heading in the main tunnel had been put in.

The tunnel is for a single track and will have a finished clear width of 16 ft. and a height of 20 ft. 10 in. above top of rail. The entire length of the tunnel will be lined with concrete. This is being done, despite the solid character of the rock, in order to protect the bore from the very outset against air slaking. The center headings are 10 x 10 ft. in size and the pioneer bores 8 x 9 ft.; the crosscuts between these two drifting operations are about 1,500 ft. apart, except that the first crosscut at the west end is 1,103 ft. from the portal.

Teamplay Important—An account of construction work on the new Cascade tunnel must be devoted largely to the contractor's plan and methods, but an essential element of the story would be missing if there were no reference to the part played by the Great Northern engineers. The spirit of adventure, which can be a great factor in the success of a project of this magnitude, was first manifested by the men who made the tunnel location survey under winter conditions. Several of the points on the survey over the tunnel were at elevations well above 5,000 ft. and long sights across canyons were



NEW GREAT NORTHERN LOCATION THROUGH STEVENS PASS

so affected by air currents that it seemed advisable to check the line, using an instrument more accurate than those available for preliminary surveys. Accordingly, a large, special theodolite was purchased with a 10-in. plate on which angles could be read direct to 2 sec. of arc. Then for eight days and nights in midwinter an observer kept constant vigil beside the instrument on a frigid, storm-swept ridge, hopefully awaiting the few moments of visibility necessary to sight through to the next station.

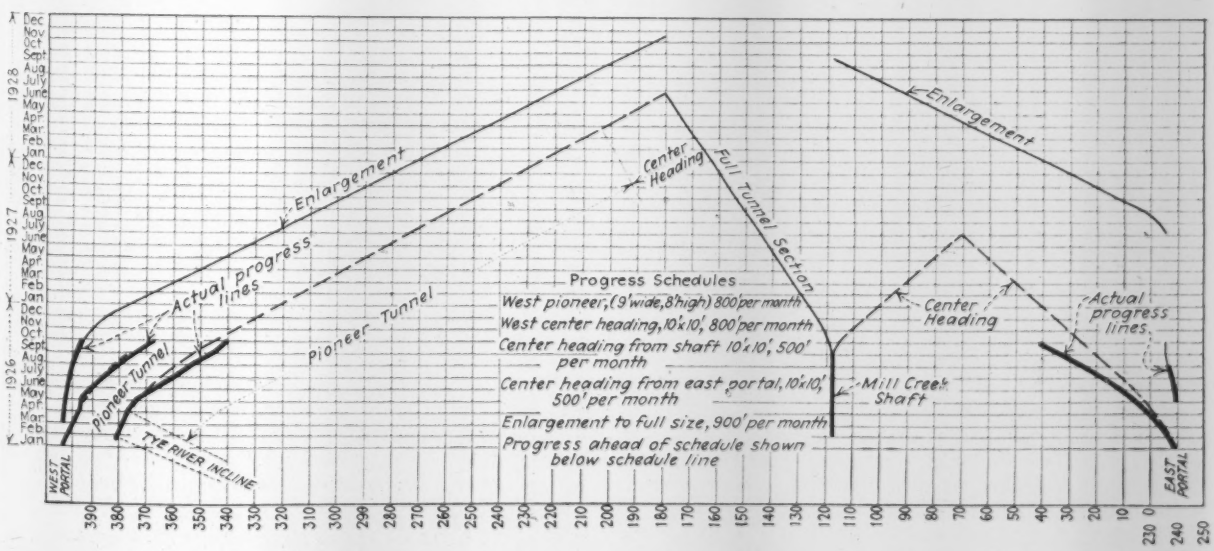
Some idea of the spirit underlying the teamplay on the job is gained from the fact that when it came time for the official picture of the men (men in the contractor's organization) who had led their crews to a new world's record, they refused to have it taken until their group included the Great Northern engineer who had given them line at the headings during this period. The engineer had repeatedly stayed on the job all night to save the crew the few minutes' delay that would have resulted if he had interrupted their work to carry the line up to the heading at times more convenient to him.

The bonus system is used in paying all men in pioneer and center headings that have to do directly with drilling and mucking, that is, the shifters' crews. These men are guaranteed, as a protection against delays beyond their control, a stipulated hourly rate varying with their position on the crew. The bonus is on a footage basis and begins when an advance of 650 ft. has been made in a calendar month. When the payrolls for the bonus crews are made up, each man is first allotted his regular pay for the entire month and the total of this regular pay is then subtracted from the product of the footage advanced and the rate per foot. This difference is the total bonus earned by the three shifters' crews and is divided equally among them on the basis of the number of hours each man has worked.

A man must be a member of his crew at the end of the month to get his bonus. If he leaves before the end of the month the amount of his bonus is automatically added to that divided among the crew as a whole. This provision has removed grounds for criticism of the system by workmen discharged near the end of the month.

A "high camp" pennant has been made with a design featuring a rocky mountain goat, emblem of the Great Northern Ry., and the camp with the best record for the month flies this pennant from the camp flag-pole during the ensuing month. This has helped to promote the friendly rivalry between the camps and the desire to "get the other camp's goat" is a factor in the frequent transfer of this pennant from camp to camp.

The spirit of the men at the headings under the combined influence of bonus, "high-camp" pennant and opportunity to break the world's record is such that not only are they alert for means of speeding progress but they carefully plan to forestall interruptions that might cause delay. Between periods of service, drills, mucking machines and other pieces of equipment used at the heading are gone over by operators, part by part,


1928
1927
1926
Dec Nov Oct Sept Aug July June May Apr Mar Feb Jan
Enlargement
Actual progress lines
Pioneer Tunnel
Center Heading
Full Tunnel Section
Enlargement
Progress Schedules
West pioneer, (9' wide, 8' high) 800' per month
West center heading, 10'x10', 800' per month
Center heading from shaft 10'x10', 500' per month
Center heading from east portal, 10'x10', 500' per month
Enlargement to full size, 900' per month
Progress ahead of schedule shown below schedule line
Mill Creek Shaft
Center Heading
Actual progress lines
Pioneer Tunnel
Tye River Incline
WEST PORTAL
EAST PORTAL
390 380 370 360 350 340 330 320 310 300 299 280 270 260 250 240 230 220 210 200 190 180 170 160 150 140 130 120 110 100 90 80 70 60 50 40 30 20 10 0 230 240 250

PRESCRIBED CONSTRUCTION SCHEDULE AND PROGRESS TO OCT. 1

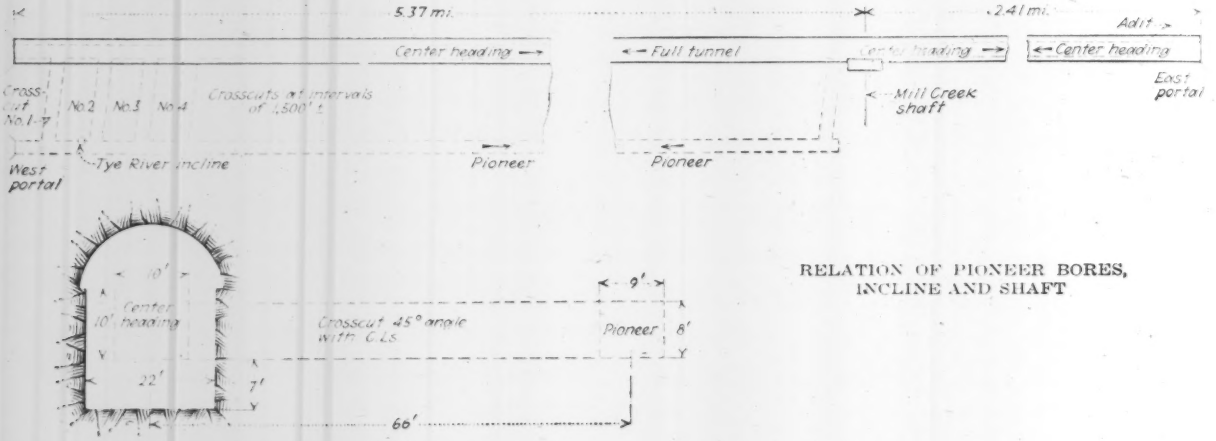
with all the solicitous care that a racing automobile gets from its mechanician.

Ground Conditions—Thus far the rock formation has been almost entirely granite. The usual outer layer of hard coarse granite was quickly traversed and beyond that the character of the rock is found to vary widely, ranging from tight, short-grained granite to softer material frequently interlain with seams of micaceous clay or graphite. These seams are often 3 to 6 ft. wide; some carry water and some do not. For the first few months the rock was very frequently an altered granite formation excellent for drilling, breaking and mucking.

The maximum flow of water up to the middle of September was 215 g.p.m. encountered in the incline leading to the west pioneer bore. The operation of getting this water out of the tunnel caused no delay, but the presence of the water did seriously interfere with progress by slowing down drilling, loading and mucking operations. The water also carried back from the heading and deposited along the tunnel large quantities of drill dust and other sediment. Layers of this sediment on the track are said to "take a set" like concrete which made track work a slow operation. This sediment has been a source of serious delay particularly in that part of the tunnel where double tracks are used. No

PERMANENT HEADFRAME READY TO BE JACKED TO PLACE

drill holes, no fixed specific program has been adopted; the scheme is almost constantly changing. The varying quality of rock termed "tightness" is considered quite as important a factor as the hardness. On the east



RELATION OF PIONEER BORES, INCLINE AND SHAFT

practicable means of preventing this deposit of sediment has yet been found. The grade of the tunnel is not sufficient for sluicing it out.

Drilling Methods and Equipment—At the west end, both in the pioneer bore and the center heading, the use of the Sullivan drill carriage with provisions for simultaneous operation of four drills has become standard. In the headings at the east end four drills are mounted on a simple, horizontal bar thus making it unnecessary to complete mucking at the face before the drills are put in action on the next round.

All drill steel on the job is heated for sharpening in oil furnaces using automatic heat control and tempering is done with the aid of a magnetic indicator. When a piece of drill steel is removed from the furnace the operator uses the indicator to test its magnetism and since the best working temperature is just above that at which the steel loses its magnetism there is thus a definite check on its proper working condition. With this combination the personal equation is largely eliminated and there is little danger of burning the steel.

Although studies are continually being made of the results of various spacings and inclinations for the end where the ground is, generally speaking, more advantageous the plan commonly used is to incline the cut holes downward and to drive the relievers horizontally, usually above 5 lifters. On the west end it has been the custom to follow the V-cut plan although in the hardest ground a pyramid cut is often used.

In the 8x9-ft. drifts the number of holes used has varied from 22 to 36 according to the nature of the rock; the footage pulled per round varies from 7 to 9 ft. As a rule about 7 lb. of 60 per cent gelatin powder is used per cubic yard of rock to be moved. As many as six different firing periods are sometimes used in a round, provided for by delay exploders, and the firing line is a 220-volt bus wire system.

Mucking Machines and Methods—Except where the full face of the main tunnel is being advanced Myers-Whaley mucking machines are now used at all the faces; a total of six of these machines was in service on the job on Oct. 1. When work on the tunnel started it was determined to try out various types of mucking machines and four different makes were selected and put to work at as many faces. The type selected was chosen

because for the condition met in this tunnel it had, in the opinion of the contractor, superior combined qualities of power sufficiency, maintenance economy, and speed.

The mucking machines get unusual care because their operators share in the contractor's desire for speed and have time on each shift, while drilling is in progress, to go over their machines. One machine which has a particularly good record worked three shifts per day for four months and ten days without coming out of the tunnel for repairs. During this time all renewals or repairs necessary were made in the tunnel between mucking periods. This was the machine used in the 937-ft. month during which time is mucked out 126 rounds, averaging 7½ ft. of advance per round, in an 8x9-ft. drift. On six of the 31 days, 5 rounds were mucked, and on 20 other days, 4 rounds. The best record on time for mucking a round was 1 hr. 40 min.

Three full faces, namely, the two portals and the full tunnel driven west from the shaft, are being mucked by air-driven power shovels rebuilt to adapt them to tunnel clearances. The principal changes were (1) cutting down booms and dipper sticks, (2) making the A-frames smaller, (3) substituting 1¼-cu.yd. rock buckets with a large area of opening, and (4) substituting crawler treads for the original wheels.

Track in these three headings is laid with extra long ties and the shovels are operated so that the crawler treads straddle the empty car track and use the outer ends of the ties as a roadway. This gives the shovels a base width such that the loaded bucket can be swung safely without using jack-arms as stabilizers. The two shovels used at the portals are Marion 41's and a lighter model—a Marion 20—was selected for the full tunnel driven west from the shaft in order that the parts might be conveniently gotten down the shaft compartments.

A convenient scheme has been developed for using power to raise the plumb posts where the full tunnel section has to be timbered. This has expedited progress because these 12x12-in. timbers, 16½ ft. long, are not easily erected without tackle. A drill bar is fastened to the power shovel frame in a position such that it projects above the roof and onto this bar a Little Tugger air hoist is clamped. A line from the hoist passes to a snatch block fastened to the wall plate some distance ahead, thence to tongs used in lifting the posts.

After some delay due to the freezing of exhaust ports in the large power shovels as the result of the cooling effects of expanding air, electric heaters were put in the air receivers. The net cost of the current used for this heating is low because the energy is in part re-

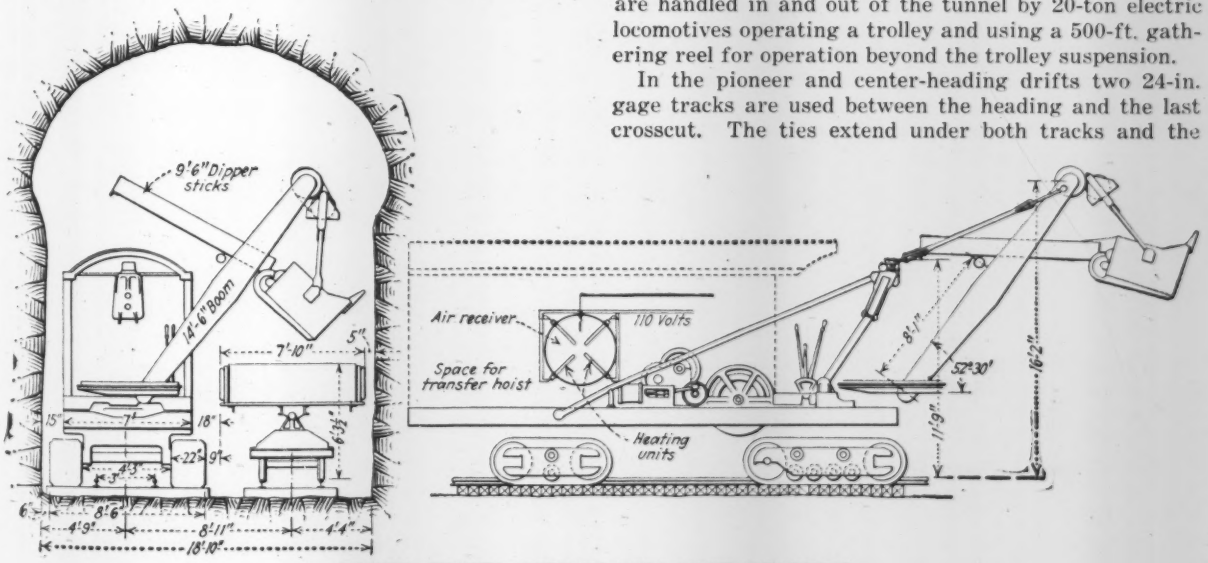
MUCKING MACHINE AT THE FACE IN PIONEER BORE

Several types of mucking machines were tried out. One worked 4 months and 10 days without coming out for repairs.

gained through the increased pressure that results from higher temperature of the confined air.

As in the smaller drifts the full section tunnel is provided with two tracks, one for empties going in and the other for outbound loaded cars. At the east end of the tunnel, where the advance is down-grade, transfer of empty cars, one at a time, from one track to the other is made with a portable cross-over which is moved ahead as the work advances. Air-operated transfer cranes for lifting the cars are now being built which are to be mounted at the rear of the power shovels. The cars to be handled by these cranes are of 6-cu.yd. capacity and weigh, empty, 11,000 lb. Trains of these cars are handled in and out of the tunnel by 20-ton electric locomotives operating a trolley and using a 500-ft. gathering reel for operation beyond the trolley suspension.

In the pioneer and center-heading drifts two 24-in. gage tracks are used between the heading and the last crosscut. The ties extend under both tracks and the



POWER SHOVEL USED IN FULL-FACE HEADINGS

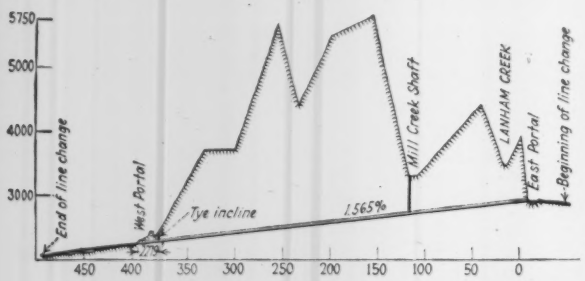
rail spacing is such that the two middle rails are also 24 in. apart. Thus the center or third track is used by the mucking machine and drill carriage.

When a new crosscut is driven through and the heading has advanced a train length beyond, the outside rail of each track, in the previous section, is taken up, the two remaining rails forming a single track. The rails removed are stored in the tunnel for use on new track ahead. Enough double track is always kept close to the face for storing empty cars. At the west portal there are in use air transfer cranes operating on their own trucks.

Air-Pressure System—At the west portal an 8-in. pipe line into the tunnel serves all compressed-air machines. This pipe is laid in the pioneer bore and is tapped by 4-in. lines at crosscuts and reduces to 2 in. for service close to the heading. All air-pressure pipes above the 2-in. size are steel tubes in 30-ft. lengths of the type used in gas works and known as "gas line" pipe. Connections between lengths are made by standard flexible couplings which allow a considerable angularity at joints. In a test after the line was ready for service, no leakage developed in a 1,900-ft. length under a pressure of 125 lb. per square inch.

A supply line made of this tubing is so flexible that it can be "thrown" one side to miss obstacles in its path or, provided there is enough slack in the line, lifted and fastened to the roof without loosening the couplings. As compared to standard threaded pipe it is claimed on this job that the tubing (1) costs only about half as much, (2) is about 40 per cent lighter and is thus more easily handled, (3) can be assembled in the tunnel in about half the time because joints are so simple, and (4) has a flexibility highly desirable in pioneer or center heading drifts where side walls do not need to be trimmed accurately. In the shaft where the joints must support the weight of the pipe, standard threaded pipe is used, for the air line and joints are made with bolted flanged couplings.

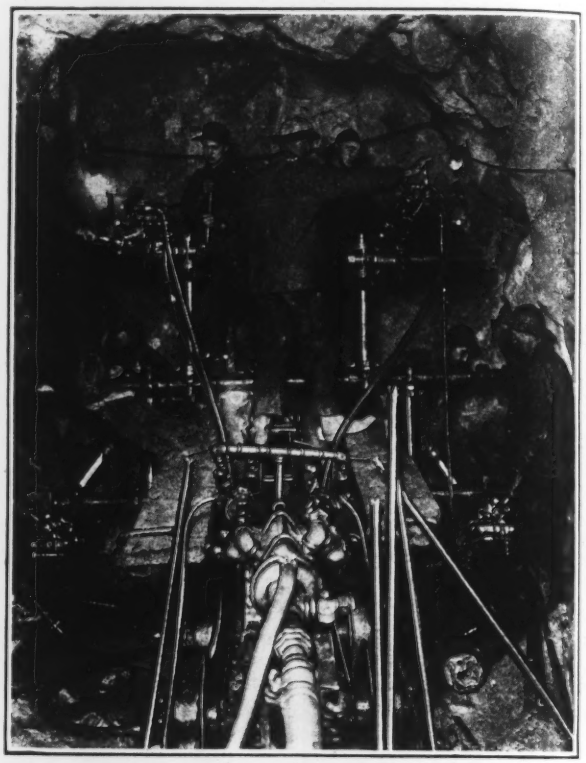
Ventilation—Ventilation is provided by means of 20-in. pipe of 18-gage galvanized iron with sleeve or band joints made up of two semicylindrical halves bolted together over ends of abutting sections. The end of this pipe is kept about 200 ft. back from the face.



PROFILE OF NEW 8-MILE TUNNEL LOCATION

Except for a few hundred feet at the starting of each drift, while the tunnel is so short that the volume of air contained is insufficient for safe dilution, the blowers are not reversed after blasting, the plan being to blow the foul air out through the tunnel.

Although several temporary expedients were used at the outset, the plan of ventilation as soon as the work is well under way will be to use the pioneer bore as a tube through which to blow in the fresh air. Then the 20-in. pipe will be used only from the brattice in the nearest crosscut to the face where blasting is in progress. Spring doors or brattices will be used, of course, at the portal of the pioneer bore and at each crosscut,



DRILL CARRIAGE IN WEST PIONEER HEADING
With this rig four drills are set up and put to work simultaneously but mucking must first be completed.

the portal of the main heading being left open for the outflowing air.

Volume blowers are used exclusively, the plan being to use chiefly blowers in units of 5,000 cu.ft. per min. capacity and to make a duplicate installation as a booster for each 5,000-ft. advance. There are two exceptions to this plan in the form of a 9,000- and a 20,000-cu.ft. per min. blower; the larger of these serves all operations at the west end.

The Mill Creek Shaft—When the point where the Mill Creek shaft was to be sunk had been located, a temporary headframe and steam hoist were promptly put in service so that work on the shaft could be carried on while construction was under way on a larger headframe and more powerful hoisting equipment. The shaft has a cross-section of 8x24 ft. outside to outside of timbers.

The permanent headframe is 87 ft. high with back legs 114 ft. long, all timbers being square hewn from logs cut nearby of a sufficient length to avoid splicing. The frame was built up, not over the shaft itself, but about 5 ft. to one side, which was just enough to clear operation of the temporary equipment. The supports were timbers that would make it possible to jack the entire frame forward into position when it was ready for service. When that time came a 15-ton ratchet jack was placed behind each of the 5 bents that constitute the headframe and the structure as a whole was jacked forward bodily into position over the shaft. The jacking was begun at 8 a.m., the moving occupied only about

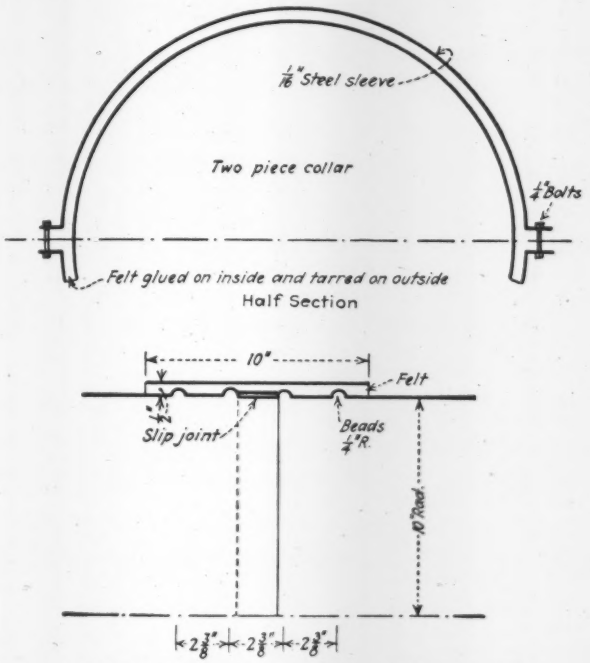
TABULATED PROGRESS TO OCT. 1 AND NOV. 15, 1926
(All figures in lineal feet)

	Dec. 1925	Jan. 1926	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Total to Oct. 1	To Nov. 15
Pioneer	40	190	224	226	100	424	458	485	83	463†	2,693	7,684
Incline	..	40	82	178	376	651	717	676	937	...	3,657 (a)*	.....
Top center heading	..	...	...	194	161	168	205	270	12	...	1,000*	.....
Full tunnel heading	..	...	...	125	125	130	177	193	222	...	972*	.....
Scenic center heading	..	...	...	...	...	56	497	548	699	639	2,439	3,113
Scenic enlargement	..	...	...	...	...	...	...	...	411	384	759	1,503
Berne center heading	5	128	331	475	495	657	707	760	665	954	5,077	6,491
Mill Creek shaft	..	...	61	1,065	1,225	78	158	133	...	...	659*	.....
Mill Creek center heading	..	...	...	...	...	...	...	...	...	159†	159	1,232
Mill Creek enlargement	..	...	...	...	...	...	...	...	...	70	70	349
												Total

(a) This is total footage driven by incline crews and includes incline proper. pioneer footage driven from foot of incline was 3,424 ft. to Oct. 1.
* Completed.
† Part month.

five hours and the rigging was completed so that the first skip was raised by the new hoist at 10:45 p.m. the same day.

The shaft, which has a total depth including sump of 659 ft., is divided into four 6x8-ft. compartments. One



DETAILS OF JOINTS IN VENTILATION PIPE

of these contains the ladder, the two ventilating pipes (one to the east and one to the west heading), the compressed air line and three pump lines. A second compartment is used by the man cage and the other two are used for two 70-ft. balanced skips. These skips are operated by the same drum, so that one rises as the other descends. There are two electric hoists; the one used for the man cage has a normal hoisting speed of 700 ft. per min, and is driven by a 200-hp. motor. The other with a hoisting speed of 1,400 ft. per min. is operated by a 350-hp. motor.

Pump capacity provided for raising water out of the Mill Creek shaft and the headings driven from it totals 2,000 g.p.m. arranged in three units. As the shaft was sunk, concrete collars were provided for catching inflowing water at two different levels. The maximum inflow into the shaft during the sinking, however, amounted to only 215 g.p.m. and all of this came in within 250 ft. of the surface.

Camp Equipment—With need for some 500 to 800 men on a remotely located job to last nearly three years, extensive provision for making labor comfortable was justified. Three main camps were established, one at the Mill Creek shaft and one at each portal. Bunk houses for common labor were made 16x32 ft. in plan and ten men were assigned to each. Skilled labor, shifters and foremen were given similar quarters, usually with six men to a house.

Men are not allowed to bring their own bedding to the job. Instead, as each man is assigned to quarters there is issued to him sufficient bedding, including two cotton sheets which he can exchange as often as they become soiled for others freshly laundered. No charge is made for this laundering but all items charged against each man must be turned in before he draws his final pay check. Convenient change and dry-rooms are provided with hot water always available for showers or in stationary tubs where the men can wash clothes. These dry-rooms have concrete floors and are equipped with individual steel lockers for all underground men. Bunk houses are swept out daily and hosed out twice a week.

Recreation halls are provided and social or athletic diversions have been encouraged with notable success. The attractiveness of the camp life and the conditions of the job as a whole are attested by the fact that with a total of 793 men on the pay roll the labor turnover has been averaging less than 1.4 per cent per day.

A total of 86 family houses were provided in the three camps. These houses were finished inside with plaster board, of 3 or 4 rooms with bath, electric lights, modern plumbing, and each community of such houses is provided with sidewalks, sewer systems and a school house. The rental for a family house is $15 to $20 per month including water, according to size. Thus far there has always been a long waiting list for these family houses and it is believed that had the contractor cared to make the initial investment required for clearing off the timber and for building construction, three times as many family quarters could have been continuously rented.

Personnel—The work on the new Cascade tunnel is being done under the general direction of J. R. W. Davis, chief engineer, Great Northern Railway Co., St. Paul, Minn., and under the personal direction of Col. Frederick Mears, assistant chief engineer of lines west. Great Northern Railway Co., Seattle, Wash. M. J. C. Andrews is resident engineer for the railway company at the tunnel. The contract for driving the tunnel is held by A. Guthrie & Co., Inc., St. Paul, Minn., and Portland, Ore., and the work for the contractors is under the general direction of J. C. Baxter, vice-president, St. Paul. Field forces for the contractors are under the personal direction of R. F. Hoffmark, general superintendent, and W. E. Conroy, assistant general superintendent. Superintendents of the three camps are as follows: Otto C. Hartman, west portal; Frank J. Kane, Mill Creek; C. J. Jones, Berne. J. B. Renwick is master mechanic.

Tests of Large Riveted Joints of Various Steels

Navy Tests of 51 Joints Show Best Results with Soft Rivets—Slip Begins at Shear of 6,500 Lb. per Sq.In.

A NOTEWORTHY program of tests of riveted joints was carried out at the Bureau of Standards a year or more ago for the Navy, mainly with a view to throwing light on the strength and proportioning of joints in plating of high-strength steel, and the suitability of high-strength rivets for joining such plates. The elaborate character of the tests is reflected in the fact that the test specimens were 10 ft. long and 22½ in. wide, that 51 joints in all were tested, and that painstaking measurements of distortion and slip were taken at a dozen or more points of each specimen.

The results, reported on Nov. 11 before the Society of Naval Architects and Marine Engineers by Commander E. L. Gayhart, Construction Corps of the Navy, are very uniform, and higher than calculation would indicate. They lead to the conclusion that rivets softer than the plates are better than rivets of equal strength or stronger, and that slip occurs at a load corresponding to about half the usual rivet stress, or at a shear of about 6,500 lb. per sq.in. High-strength steel showed considerably lower slip resistance than normal structural steel. The stress distribution between the several rivet rows was not uniform, but depended on the number of rows and on whether the outer row was full. Nevertheless the ultimate strength of all the joints showed no definite influence of this irregularity.

All the joints tested were identical in size and plate thickness, except for the width of butt straps and number of rivets. Each joint was 120 in. long over all, and was made of ¾-in. (30-lb.) plate 22½ in. wide in the middle portion, the grip ends being wider. Edges were machined and rivet holes were drilled (1 1/16 in., for 1-in. rivets), burrs being removed before riveting. The rivets were driven by pneumatic hammers. Seven forms of joints were tested, including double-, triple- and quadruple-riveted, some with alternate rivets in the outer row omitted and some with the butt strap on one side narrower than that on the other. In all cases there were five lines of rivets in the 22½-in. width, at 4½-in. spacing, with 3-in. longitudinal spacing between rows.

Each type of joint was made in both medium steel (ordinary structural steel, tensile strength of coupons 57,000 to 65,000 lb. per sq.in.) and of high tensile steel (test coupons 78,500 to 87,600); in addition, four joints were made of special treatment steel, of a type used for ballastic protection on ships, but the results are not reported. All joints other than the double-riveted had more rivets than necessary to develop the strength of the plate, and therefore shear failures occurred only in the double-riveted joints.

There were few loose rivets, and these had no effect on the test results. The workmanship is described as somewhat better than usually obtained in ship work. Almost all the tension failures occurred through the net section of the plate.

Three specimens of each joint were tested: one by direct loading to rupture, to determine the stress distribution between rivet rows, while two were tested for slip, the load here being applied and released in a number of stages.

The shear failures, Commander Gayhart states, developed the full efficiency of the rivets or better, calculated on the basis of assumed strengths of 50,000 lb. per sq.in. of rivet area for medium steel and 64,000 for high tensile steel. The tension failures showed efficiencies up to 10 per cent higher on net section than computed from the strength of the test coupons.

All the joints developed 80 to 85 per cent efficiency on gross section (instead of 76 per cent, the theoretical value), and there was little variation between the different types of joint. Omission of alternate rivets in the outer row did not increase the gross efficiency.

First slip occurred in the medium-steel joints at rivet shears of 6,000 to 7,000 lb. per sq.in. of rivet area, with a total range from 4,000 to 7,500 lb. The highest slip values were those for two-row riveting; with increase of number of rows the slip values decreased *pro rata*. Much lower slip values were registered for the high-tensile steel, the values being only a little over half of those for medium steel.

The stress distribution between the successive rivet rows showed considerable irregularity at low loads, the outer rivet row taking the lowest stress. But at higher loads the stresses of the different rows tended to equalize, reaching practical uniformity at ordinary working stresses in all the joints except the double-riveted joints. In these latter, the outer row remained underloaded at all stresses, the inner row taking two-thirds of the total load. In spite of this fact, the ultimate strength of these joints was not inferior to that of the other joints.

High-strength rivets in high-strength plates showed no advantage over medium steel rivets, and in fact the latter showed marked superiority in slip resistance.

Permanence of Modern City Building Prophesied

Col. J. R. Kilpatrick, vice-president of the George A. Fuller Co., New York, declared in an address before the American Construction Council at Cleveland last week that modern city buildings would survive and be in continued use for many generations. "I predict," he said, "that our children's grandchildren will be living and working 100 years from now in the honestly built steel and masonry buildings being erected throughout this country and abroad by the big American construction companies. These buildings will not have outlived their usefulness within the span of a century or longer." The fact that we have few buildings now surviving that have reached the age of 100 years he attributed to light and temporary standards of construction of former times. The building practices of the revolutionary period in this country were makeshifts, he said, and generally used poor materials and the available unskilled labor. Buildings erected in the larger European cities at that time, however, are surviving and are serving useful purposes. Today, on the contrary, our construction standards are superior to those of Europe; America is now in the age of permanency in construction and is far ahead of any other country in the world. "It was American-built buildings that successfully withstood the Japanese earthquake in 1924, and the well designed, honestly built steel and masonry buildings in Florida were not damaged by the terrific hurricane two months ago. The structurally slighted and 'jerry-built' buildings suffered severely or went down before the storm."

Repairing Old Concrete Lining on Two-Track Railroad Tunnel

Grouting Cracks Followed by Guniting Onto Mesh Reinforcing Successfully Used on Large-Bore Tunnel

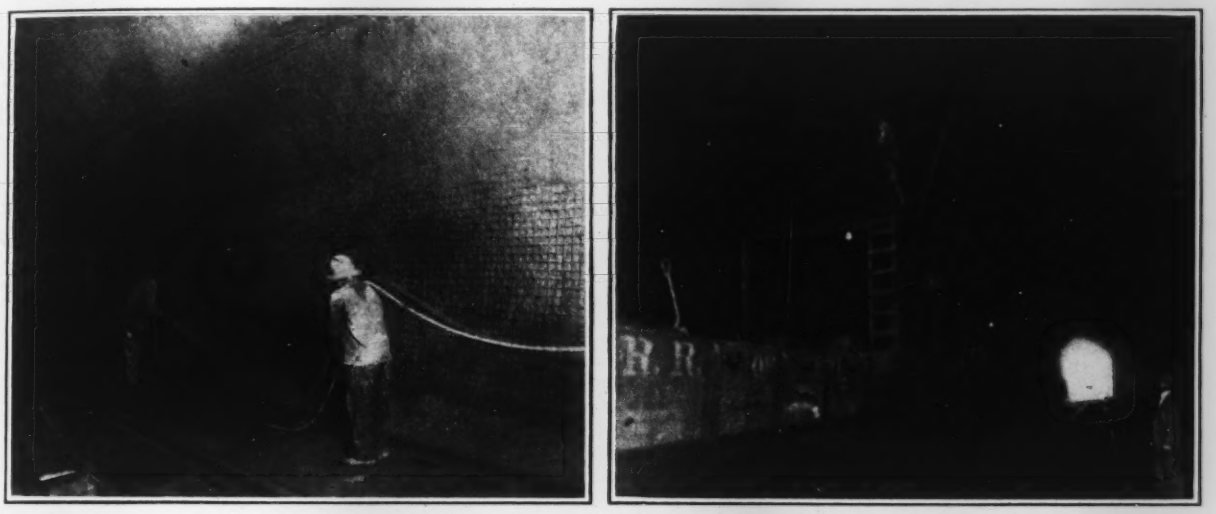
By H. H. Temple
Chief Engineer, Pittsburgh & West Virginia Ry. Co.

GREENTREE TUNNEL, 5 miles south of Pittsburgh, Pa., on The Pittsburgh & West Virginia Ry., is a double-track bore 4,716 ft. in length and was holed through in 1903, as a part of the Wabash transcontinental system construction. In 1908-09 a concrete lining 24 to 30 in. thick was placed in this tunnel by the pneumatic method. Within a few years after placement, the concrete lining showed signs of disintegation particularly at wet spots near the portals. This disintegration for a number of years was considered of minor importance and where necessary brick patching was resorted to. In 1920, longitudinal cracks were first noticed in the lining. In general these cracks appeared at the spring line or center line and varied in length from 50 to 300 ft. By 1925 these cracks had opened up and the disintegration of the concrete had advanced to such a stage that it became necessary to make repairs of a major nature.

Full consideration was given to the method of placing a three-ring brick arch from spring line to spring line, but because of the excessive cost and heavy chipping required to maintain clearance a more economical method was sought. After a careful investigation of various methods, it was decided to repair a section 600 ft. long at the south portal by first grouting the cracks and packing and then replacing the disintegrated concrete with gunite. Grouting was started April 28, 1926, and by July 1 sufficient progress had been made to permit starting the gunite work. During the period 4,140 bbl. of cement were used for grouting using a 1:2 mix. The grouting has proven most successful and has apparently accomplished the three major purposes of sealing the cracks, solidification of packing and stopping the greater part of the seepage.

The causes of the disintegration of the concrete are many. Those of major importance are porosity, which has allowed infiltration of sulphur water from overlying coal mines thus causing a leaching out of the cement, mechanical and chemical action of the locomotive blast and frost action near the portals.

Prior to guniting all disintegrated or inferior concrete (in places to a thickness of 2 to 8 in.) is chipped off until a solid and durable surface is exposed; anchor bolts are then placed on about 24 in. centers and to these bolts is attached a single layer of galvanized reinforcing mesh. After the mesh is in place and immediately before guniting the surface is thorouhly cleaned and sandblasted. The gunite is then placed in as many coats as are necessary to obtain the desired thickness but in no place is the gunite less than 2 in. thick nor is the mesh closer than one inch to the finished gunite surface. No difficulty has been encountered to date in completely stopping all seepage.



CONCRETE LINING OF TUNNEL REPAIRED BY GROUTING AND GUNITING

Equipment for the work consists of two grout guns mounted on push cars with elevated platforms, two air compressors with a total displacement of 900 ft. located at the portal, one cement gun for guniting and one for sand blasting, a mixer, air drills, air hammers, etc. Chipping and placing of mesh are handled from a platform erected on a gondola and sandblasting and guniting from a second gondola similarly equipped as shown in the illustration. One track is available at all times so that there is no delay to the repair work other than that occasioned by smoke.

It is considered that this method of repairs will accomplish the following results: (1) Seal the cracks in the concrete lining; (2) solidify the packing and overlying strata of shale and rock; (3) stop all seepage; (4) prevent the infiltration of air into the porous concrete, which acting in conjunction with the sulphur water will cause leaching out of the cement in the concrete, and (5) prevent further locomotive blast or frost action by presenting a hard, durable surface of maximum density at the exposed face of the tunnel lining.

Grouting is being done by the maintenance forces of the railroad company. The gunite work is being done by the Fritz-Rumer-Cooke Co., railroad contractors, Columbus, Ohio, under the general supervision of Kennerly Bryan, Jr. All work was planned and is being executed under the direct supervision of the writer.

Large Mixing Plant Tried Out on Road Work

Two Miles of Road a Week Was Goal Set for Twin Mixers Mounted on Traveler and Served by Industrial Railway

By R. T. Giles
Physical Testing Engineer, North Carolina Highway Commission, Raleigh, N. C.

THE INCREASE in demand for high type roads has made it necessary to apply manufacturing, or mass production methods. An ideal opportunity for doing this was created when the North Carolina Highway Commission decided to let approximately 30 miles of hard surface on Route 40 between Rocky Mount and Halifax. This contract was secured by James O. Heyworth, Inc., of Chicago, who decided to go a step further than had been reached up to this time by having a special twin mixer plant built. The capacity of each mixer is 1.3 cu.yd. of concrete. The mixers are mounted parallel and on the same truck for advancing, but each is independent of the other as far as operation is concerned.

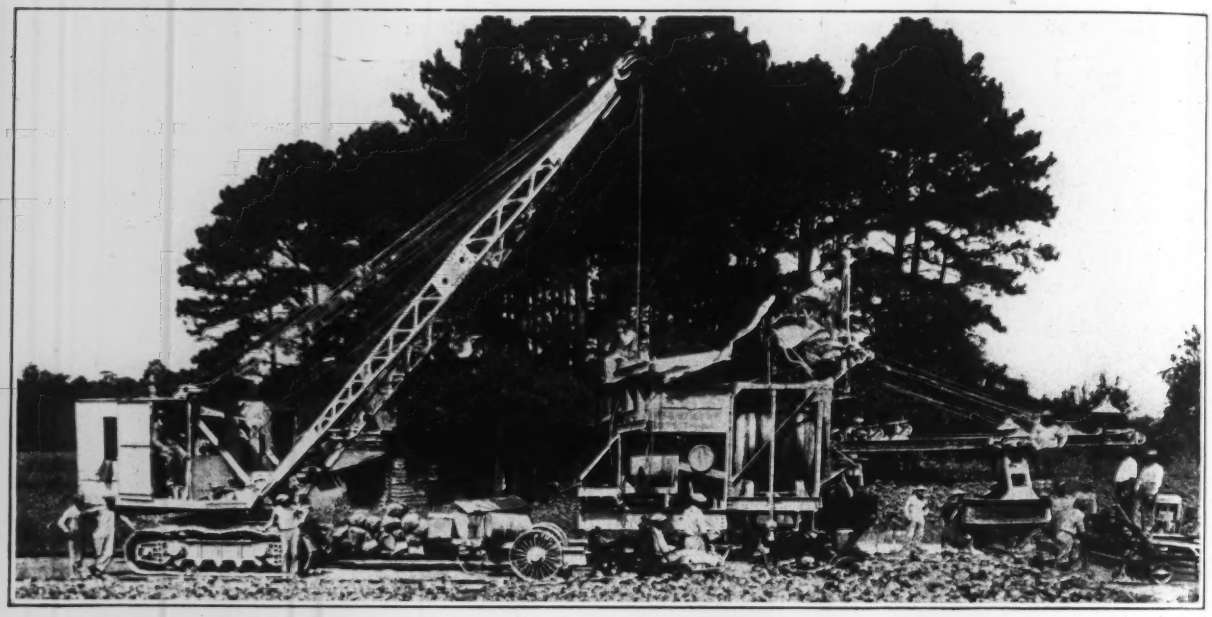


FIG. 1—PAVING PLANT OF TWIN MIXERS AND CHARGING CRANE

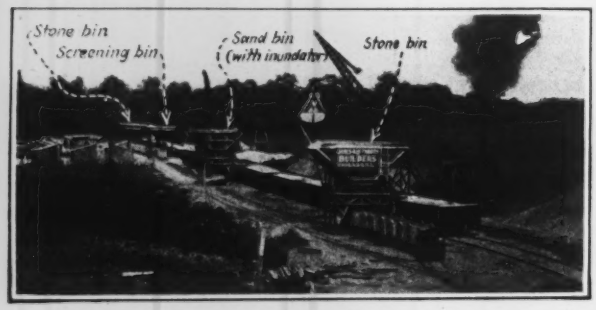


FIG. 2—LOADING YARD SET-UP FOR TWIN-MIXER CONCRETE-PAVING PLANT

With a plant of this capacity the problem was to keep it supplied with material. Since the specifications called for a 1½-minute mix, it was considered reasonable to expect a batch each two minutes from each mixer, or a batch each minute from the plant. With this as a basis, and knowing the mix to be a 1:2:4, it appeared that for a ten-hour day, working to capacity, the materials required would be 1,200 bbl. of cement, 10 cars of fine aggregate and 20 cars of coarse aggregate.

In trying to maintain this schedule many difficulties were encountered, some of the more pronounced of which were:

First, bulk cement was used to start the job, and this gave serious trouble in transferring the cement from the cars to the cement house, and in weighing the cement fast enough to avoid delays at the mixer. After thorough trial bulk cement was abandoned for sack cement.

Second, inundated sand is used and since the cement is hauled on top of the industrial batch boxes it is necessary to keep the cement separated from the wet sand. The plan was first tried of putting the wet sand in the bottom of the dump-bottom batch boxes with the stone next, to be followed by the cement. With this arrangement it took 3¾ minutes for the material to go through the mixer and only gave a one-minute mix. This delay was caused by the wet sand coming into contact with the hopper immediately over the mixer and choking the valve to the mixer. By splitting the stone into half batches, and loading a half batch of stone, the wet sand, the other half batch of stone, and then the cement, the time of travel through the mixer was reduced to 1 min. 55 sec., of which 1½ min. was actual mixing time.

For unloading the material from the freight cars and loading it into the bins two locomotive cranes with 1½-cu.yd. buckets are used. At different periods during the construction screenings have been used up to 38 per cent of the fine aggregate. During such periods the rotation of bins and stock piles was: Coarse aggregate, screenings, sand, coarse aggregate and cement. The first crane would serve the first stone bin and the screenings, while the second crane served the sand and the second stone bin. With this arrangement it is possible

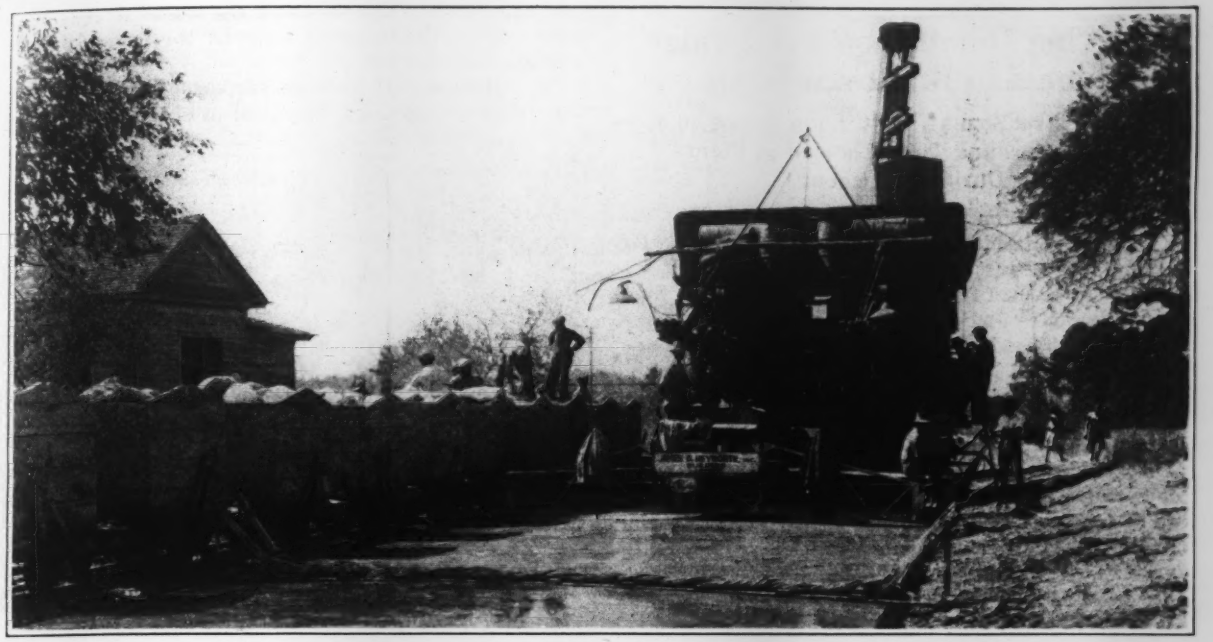


FIG. 3—BEHIND THE PLANT, SHOWING TWIN MIXERS AND BATCH-BOX TRAIN

to get material to the mixer except when the haul exceeds six miles. In doing so it takes 145 batch boxes and 14 dinkies. The number of bypasses necessarily depends upon the distance the mixer is from the plant.

A finishing machine is used, followed by the standard finishing tools specified by the highway commission. Calcium chloride, which is incorporated in the mix, is used to cure and the fresh concrete is covered with burlap, which is kept wet until the concrete has taken its final set. The crane, which handles the batch boxes to the mixer, also furnishes the power to advance the mixer. The combined weight of the mixer and crane is 75 tons, which greatly exceeds the designed carrying capacity of the bridges. This makes it necessary to place supports under all bridge spans before the equipment is taken across. The crane is also used to put the finishing machine on the mixer to be taken across the bridges.

A telephone system connects the plant with the mixer at all times so that communication can be established on very short notice. For work after dark two 2,000 watt lighting systems are used at the proportioning plant, and light at the mixer comes from the crane engine.

It was thought before the job started that the setting of forms and the grading for them would be a problem. With the use of a form grader this anticipated trouble did not develop to the point of being really a problem. After the forms are set the subgrader is used, which leaves the subgrade just a little high. This is taken care of by blades mounted on a board behind and attached to the mixer.

It has been necessary to furnish a camp for the employees. Wooden shacks were first used but the contractor is changing over to tents so that moving can be speeded up. With so much equipment it is necessary to carry a very complete line of spare parts. These are taken care of by a freight car fixed up as a stock room. The repair shop is also in a freight car so that when the time to move comes all that is necessary is to shut the doors and the stock room and repair shop are ready.

With the mixer running ten hours per day and a mix a minute it is possible to pour two miles of 8-7-8-in. concrete road, 18 ft. wide, each week. While this production has not been realized, the contractor is at present securing 1,500 lin.ft. per day, 1¼ miles per week.

Parking Survey in Chicago

IN THE report of the recent traffic survey undertaken by the Chicago Association of Commerce, the following statements are made as to the parking problem:

The primary effect of parking is to reduce the capacity of the roadways of typical business districts in Chicago from 30 to 50 per cent, converting roadways capable of carrying three lines of vehicles into two-lane streets, and roadways capable of carrying two lines of vehicles into one-way streets. The lessened capacity is aggravated on narrow traction streets, for here parking forces all traffic onto the tracks, making it necessary for vehicles to follow in the wake of street cars, and the street cars in turn to be regulated by the movement of slow vehicles.

The secondary results of parking are the most serious. With the curbs filled to capacity from early morning until the close of the business day, no space is left for the loading and unloading of passengers and merchandise from vehicles which are to be stopped temporarily for this purpose. Thus curb storage in the more crowded sections has regularly resulted in the creation of double line parking, which is the most serious threat found in any part of the entire traffic parking. It is to be witnessed at any time and at practically any place either in the central or outlying business districts. Double-line parking, except on very wide streets, takes two-thirds and in many cases the entire width of the right side of the roadway, blocking all traffic there.

Much of the congestion on the streets is not the result of density of traffic nor of the physical conditions of the streets but rather of an unsystematic use of existing facilities, and a failure to adjust satisfactorily the rights and duties of street users of various classes. Heavy horse-drawn drays contribute a substantial part of the congestion of traffic on certain streets in the central business district. The survey knows of no other high-grade retail district in the country that is so filled with heavy commercial trucking, much of which is horse-drawn, as is State St. Horse-drawn vehicles now make up 4.5 per cent of the total traffic of the central business district between 7 a.m. and 7 p.m. but the congestion they develop far exceeds this percentage.

Erecting Dumbarton Toll Bridge on San Francisco Bay

Assembled Steel Spans 225 Ft. Long Towed 30 Miles on Barges and Then Chained to Piers During Placement

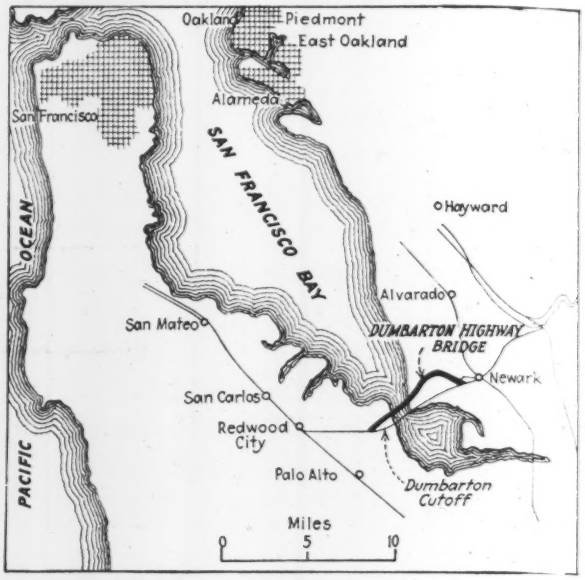
THE Dumbarton highway bridge recently constructed across the lower part of San Francisco Bay is one of the largest toll bridges in the West. It was financed on the plan frequently used where public funds are not available and private interests are given franchise for a toll road; that is, the board of supervisors of the county on the left bank grants a franchise to build and operate the bridge, reserving certain regulatory or control rights. In this case the franchise terminates at the end of a 50-year period without any provision about the ownership of the bridge transferring to the county. Regulatory control is maintained by fixing the initial rate of toll in the franchise and providing for a reduction of tolls when a stipulated rate of return on the investment has been reached. The basis for the initial toll schedule is 20c. for a two-passenger car, 30c. for a 5-passenger car, etc., plus 5c. per passenger. Truck tolls range from 40c. for a one-ton truck up to $1.25 for a 10-ton truck.

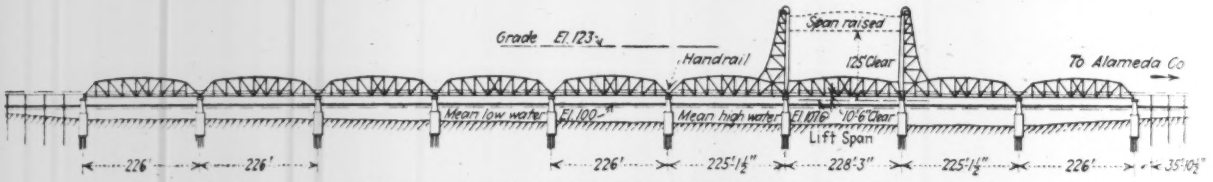
The Dumbarton bridge crosses the southern arm of San Francisco Bay about 35 miles by water from the Golden Gate, thus affording an east-and-west connecting link between trunk highways on either side of the bay that travel, in general, in a north and south direction. To pass around the extreme southern end of the bay requires going some 10 miles beyond the Dumbarton crossing. The bridge will afford a new and shorter route to San Francisco for traffic coming through Niles Canyon from the San Joaquin Valley which has heretofore gone through the city of Oakland and thence across the bay on a ferry.

The Dumbarton bridge project consists of three divisions: (1) the structural steel spans, resting on concrete piers and including a lift span which gives a clearance of 135 ft. above high tide; (2) the concrete pile trestle on both sides of the steel structure; and (3) the approach roadway on an earth fill at both ends of the bridge. There are nine truss spans each 225 ft. in length; the concrete pile trestle on the west side is about 2,200 ft. long and on the east side about 2,100 ft. long; the length of the approach fill on the west is about 1.8 miles and on the east side about 3.6 miles. Thus the franchise holders will really operate a 7-mile toll road of which the bridge constitutes the central part.

The roadway on the bridge, which is a concrete pavement, is 24 ft. wide. The approach fills are 40 ft. wide of which 24 ft. is hard surfaced, supplemented on each side by 3 ft. of rock and 5 ft. of earth. The average depth of the fill above the marsh level is made about 4 ft. Construction work on the bridge was recently completed.

The piers are of concrete supported on piles. They consist of two sections, the upper or shaft section about





LOCATION AND ELEVATION OF DUMBARTON BRIDGE

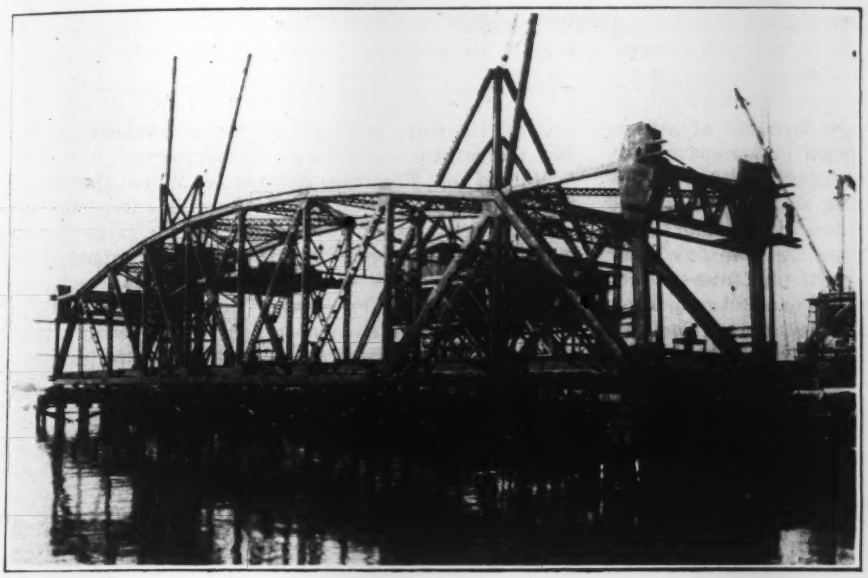
31 ft. high, of the dumb-bell type, and the rectangular base, on which the dumb-bell section rests, of height varying up to 43 ft. The base section was made by sinking timber cribs, driving piles inside of them to a penetration of approximately 40 ft., placing concrete by means of a tremie up to a point about 20 ft. below low water and then unwatering the crib for the cutting off of the piles and the finishing of the pier. The lower part of the crib served as a form for the concrete and remains in place. The upper part served only as a cofferdam and was made separate so that it could be lifted off and reused after the shaft of the pier was completed.

The trestle supported on concrete piles is of standard construction, using piles 20 in. square that average 73 ft. in length. In the deeper water longer piles ranging up to 80 ft. and of maximum section 24 in. square were used in the trestle.

The feature of the work of special structural interest was the handling of the steel spans, 225 ft. long, which were erected at the steel plant in Oakland 30 miles from the bridge and towed to the site, one at a time, on a barge 130 ft. long specially equipped for this purpose.

The spans were erected on falsework at the fabrication yard within reach of the yard derricks and convenient for transferral to the barge. They were then rolled sideways clear of the falsework, the barge placed under them at low tide and the incoming tide lifted the

span from the runways. Even with the span placed longitudinally on the barge the ends projected beyond the points of support so much as to require the stiffening of some of the chord and web members by temporary timber braces to provide for the stresses from the dead weight. This bracing was put in before the spans were loaded.



LIFT SPAN ROLLED OFF FALSEWORK AND READY FOR BARGE

The spans were towed to the bridge site when tide and wind were favorable and carefully placed in position on the piers. To facilitate this placement a pair of cables and two chain blocks were attached to the lower chords of the span near the end panel points at both ends of the span and as the span was jockeyed into approximate position between the piers these cables were connected to the tops of the piers. These cables and blocks virtually constituted a mooring for the barge with its span and by manipulating the chain blocks the spans were accurately located in the exact position required and held there while being lowered onto the pier.

Each span had on either end a wood framework put on at the erecting plant from which a plumb-bob could be suspended to indicate accurately a predetermined point on the center line. The corresponding point had previously been marked exactly on the concrete top of each pier so that, in the operation of placing, the chain blocks were manipulated until the plumb-bob supported by the span floating on the barge exactly coincided with the point marked on the concrete whereupon the steel span was allowed to rest on its concrete support.

LIFT SPAN FLOATING TO PLACE ON BARGE

The lowering was accomplished mainly by the fall of the tide. The barge, however, was divided into two small compartments at each end and a large center compartment, each equipped with sea cocks. The small end compartments were used to "trim" the barge so that the fixed end of the span would land first with the span level transversely. The center compartment was then flooded by the sea cocks to facilitate removing the barge quickly after the piers began taking the weight of the span. The latter was more important because of the tidal currents which increase rapidly as the tide falls.

The piers were prepared for the spans by bush-hammering their tops to exact level under the location prescribed for the shoes. A thin layer of grout was placed over each bush-hammered area immediately before the lowering of the span. The shoes were put on the trusses at the time of assembly and thus came into bearing on the piers when the spans were lowered.

This method of placement was speedy and accurate, due to the fact that with the overhang on either end of the barge there was ample room for maneuvering to get into position prior to lowering, as the steel spans could move without interference over the tops of the piers. The only occasion for very exceptional care came in placing the last span where clearance was limited.

The bridge has been built by the Dumbarton Bridge Co. according to the designs of Harrington, Howard and Ash, consulting engineers, for whom Frank M. Cortelyou was resident engineer in charge of construction. The Moore Dry-Dock Co., Oakland, Calif., was the contractor for the steelwork, and Healy-Tibbitts Construction Co., San Francisco, for the piers, concrete pile trestles and concrete deck.

Making Money Out of Sewage

The possibility of making money from sewage [at least where rainfall is deficient for crops] was urged by Charles G. Gillespie, director, Bureau of Sanitary Engineering, California Board of Health, in a recent paper on sewage disposal before the League of California Municipalities (*Pacific Municipalities*, August, 1926). Said Mr. Gillespie, in part: "I believe we should go into the business of making money out of sewage. There is profit in the manurial values and in sale of water for irrigation. The water itself is a good fertilizer. The arid West needs all the water it can get. The city of Pomona has already contracted for the sale of its effluent at 6c. a miner's inch in summer and 9c. in winter. The average return is a little under 1c. per 1,000 gal., or about $3.25 per acre-foot. Many parts of California pay more than this for straight water. Crops are raised at a profit where irrigation water costs $30 to $50 per acre-foot."

Bio-Chemical Oxygen Demand of Raw and Treated Sewage

Studies of Results from Screens, Tanks, Sprinkling Filters and Humus Tanks and Comparisons of Data at Baltimore with Ten Other Plants

By C. E. Keefer and R. T. Regester
Engineer of Sewage Disposal, and Junior Engineer, of the Bureau of Sewers, Baltimore, Md.

THE BIO-CHEMICAL oxygen demand of sewage is gradually assuming a more important role in the minds of sanitary engineers. Although this determination has its uncertainties, and at times should be interpreted with caution, it often gives a more complete idea of the strength of a sewage than any other chemical analysis. One point of particular interest with reference to the bio-chemical oxygen demand is to know how it varies with the solids in raw and treated domestic sewage collected in a separate system of sewers. Some of the more pertinent questions are, has a sewage with a high solid content substantially as high an oxygen demand as a sewage with a low solid content? How does the reduction in the oxygen demand vary with the

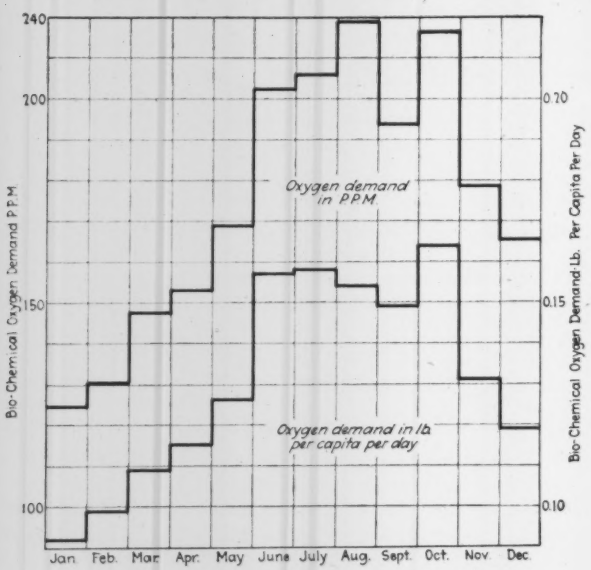


FIG. 1—AVERAGE BIO-CHEMICAL OXYGEN DEMAND OF BALTIMORE RAW SEWAGE, 1919-25

reduction in solids after the sewage has passed through settling tanks, and trickling filters? There appear to be scant, if any, data on these and similarly related questions in the literature of sewage treatment. A study was, therefore, made of several thousand sewage analyses at the Baltimore sewage-works with the idea of throwing light on these problems. It is apparent that considerably different results would be obtained by studying a sewage containing appreciable quantities of industrial wastes or one collected in combined sewers. But since the sewage at Baltimore is typically domestic in character and is reasonably free from storm water, the following study is offered as an index and also as a basis for future comparison to show in a general way the relationship between the oxygen demand and the solids in raw and settled sewage, and trickling filter and humus tank effluent. Many factors will naturally affect this relationship, as length of flow and velocity of sewage, temperature, and water consumption.

Method of Treating Sewage — When the sewage reaches the Baltimore plant, there is rarely any dissolved oxygen present, and most of the large floating material has been considerably reduced in quantity due to the great length of travel in the outfall and intercepting sewers. The sewage then flows through bar screens with ⅜-in. clear openings to two settling tanks, each with a capacity of 3.8 m.g. and a theoretical deten-

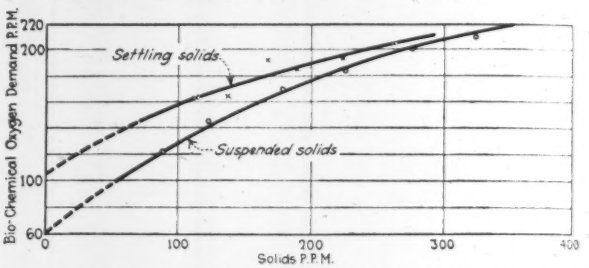


FIG. 2—RELATION BETWEEN SOLIDS AND BIO-CHEMICAL OXYGEN DEMAND IN BALTIMORE RAW SEWAGE, 1919-25

tion period of about 3.3 hr. when the flow is 55 m.g.d. Next the sewage passes through cylindrical drum screens to 30 acres of 1 to 2½-in. stone trickling filters, 8½ ft. deep. Finally the sewage flows through two 5.7-m.g. humus tanks, which have a detention period of 5 hr. when the flow is 55 m.g. a day.

"Standard Methods for the Examination of Water and Sewage," as adopted by the American Public Health Association, was followed in making the analyses. The dilution method was used in determining the bio-chemical oxygen demand of the sewage, which was incubated for one day at 37½ deg. C. The settling solids were determined by allowing 2,400 c.c. of sewage to settle for 3½ hr., and then siphoning off as much of the supernatant as possible. The amount of remaining solids was then found.

Oxygen Demand of Raw Sewage—Table I gives the sewage flow from 1913-25 together with the oxygen demand in parts per million and pounds per capita per day. The oxygen demand during the three years 1916-18 was unusually low, averaging 0.09 lb. per capita, against 0.14 for the other 10 years from 1913-1925. It is difficult to give the reason for this condition. It is interesting to note, however, that this low demand occurred during the war period at a time when efforts were made to conserve the food supply and reduce waste to a minimum. That the war and its effect upon the food supply had a direct bearing upon the composition of the sewage of at least one large European city is borne out by S. Stroganoff in his studies at Moscow ("The Food of the City of Moscow in 1903-22 with the Sewage Analyses").

The oxygen demand of the raw sewage in parts per

million and pounds per capita per day is shown in Fig. 1 by months from 1919-25. The oxygen demand is low during the winter with a minimum of 0.092 lb. per capita per day in January. From then until the summer months there is a gradual increase. An examination of the individual monthly results shows that it is not consistently low in winter and high in summer, but the results shown in Figs. 1 are typical. What appears

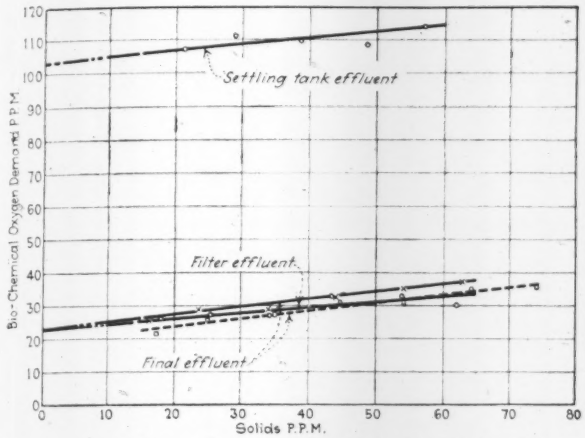


FIG. 3—RELATION BETWEEN SOLIDS AND BIO-CHEMICAL OXYGEN DEMAND IN TREATED SEWAGE, 1921-25

to be the chief reason for a stronger sewage in summer is that the temperatures are higher. Septic action, therefore, increases, and the sludge deposits in the outfall conduit unite again with the raw sewage.

The relation between the suspended and settling solids and the bio-chemical oxygen of the raw sewage, 1919-25, is given in Fig. 2. The points on these and the other curves described in this article are averages of several hundred analyses. As is to be expected, the oxygen demand increases with the solids. However, the rate of increase is less as the amount of solids becomes greater. One explanation for this condition is that as the solids in the sewage increase, the relative

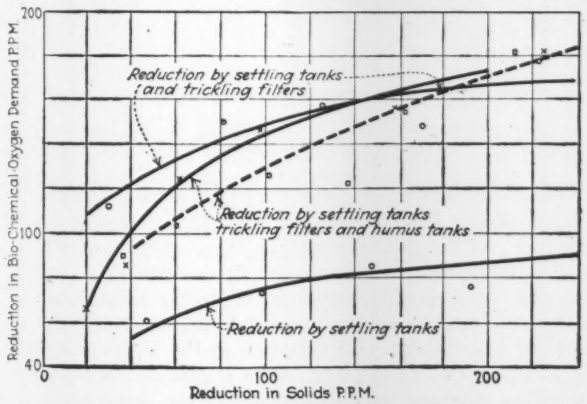

Reduction by settling tanks and trickling filters
Reduction by settling tanks trickling filters and humus tanks
Reduction by settling tanks
Reduction in Bio-Chemical Oxygen Demand P.P.M.
Reduction in Solids P.P.M.

FIG. 4—RELATION BETWEEN SOLIDS REMOVED AND REDUCTION IN BIO-CHEMICAL OXYGEN DEMAND, 1919-25

amount of inorganic to organic material is greater. A high solid content is caused by street wash getting into the sewage during storms through the opening in manholes and through a few storm drains, and also to the solids in all stages of decomposition which have settled in the outfall sewer but which are carried along with the sewage as the velocities increase. The bio-chemical oxygen demand of these solids has decreased to a certain degree through the process of decomposition, and when they are added to the fresh solids of the raw sewage, the oxygen demand is not increased proportionately. One other point of interest with reference to these curves is that if they are made to intercept the Y-axis, the oxygen demand of the dissolved solids is shown to be 60 p.p.m. and of the non-settling suspended solids 44 p.p.m. These values apply only when there are no suspended or settling solids in the sewage.

Oxygen Demand of Treated Sewage—Fig. 3 shows how the oxygen demand increases with the settling solids in the effluent from the settling tanks. If this curve is extended to meet the Y-axis, the oxygen demand of the non-settling and dissolved solids is 103 p.p.m., which is about the same as for the raw sewage. Sedimentation, as is shown by the curves, has had no effect on these solids. The rate of change of the oxygen demand of the sewage with the solids (the first derivative of the curves), which is a measure of the strength of the sewage in terms of its solid content, is less in the case of the settling tank effluent than in the case of the raw sewage. In the former instance it has a constant

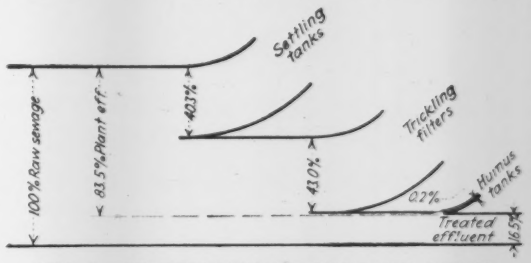


FIG. 5.—OXYGEN-DEMAND BALANCE, 1919-25

value of 0.2 lb. of oxygen per pound of settling solids, and in the latter case the oxygen demand varies from 0.6 lb. of oxygen per pound of settling solids, with no settling solids in the raw sewage, to 0.2 lb. of oxygen per lb. of settling solids, with 280 p.p.m. of settling solids.

Fig. 3 also shows the relation between the oxygen demand and the solids after the sewage has passed through the trickling filters and the humus tanks. A comparison between the curves showing the settling tank effluent and the filter effluent will indicate the role played by the trickling filters. If it is assumed that the settling solids entering and leaving the filters are approximately the same in amount, and such is frequently the case except during unloading periods, the reduction in the oxygen demand produced by the trickling filters for any definite settling solid content is the difference between the ordinates of the curves marked

TABLE I—SEWAGE FLOW AND BIO-CHEMICAL OXYGEN DEMAND BALTIMORE SEWAGE-WORKS, 1913-25

Year	Contributing Population	Sewage Flow — Total M.G.D.	Sewage Flow — Gal. per Capita per Day	Bio-Chemical Oxygen Demand of Untreated Sewage P.P.M.	Bio-Chemical Oxygen Demand of Untreated Sewage Lb. per Capita per Day
1913	91,535	18.10	198	115	0.190
1914	176,935	22.94	130	131	0.141
1915	279,275	31.80	114	113	0.107
1916	376,385	39.27	104	91	0.079
1917	438,000	44.38	101	90	0.076
1918	479,295	52.84	110	67	0.062
1919	501,540	55.06	110	127	0.116
1920	511,250	52.12	102	171	0.145
1921	525,035	46.62	89	149	0.110
1922	546,830	47.49	87	195	0.141
1923	573,820	48.17	84	235	0.164
1924	616,025	53.50	87	163	0.118
1925	673,240	55.09	82	179	0.122

TABLE II—OXIDIZING POWER AND COMPARATIVE EFFICIENCIES OF SETTLING TANKS, TRICKLING FILTERS, AND HUMUS TANKS AT ELEVEN SEWAGE-WORKS
(All Values in Parts per Million)

City	Reduction in 5-Day Oxygen Demand By: Settling Tanks	Trickling Filters	Humus Tanks	Change in Total Oxygen By: Settling Tanks (—)	Trickling Filters (+)	Humus Tanks (+)	Oxidizing Power of: Settling Tanks	Trickling Filters	Humus Tanks
Alliance	24	....	...	3.0	....	...	21	....	
Atlanta-Intrenchment	39	18.8	...	...	14.3	...	39	33.1	
Atlanta-Peachtree	32	16.1		...	11.7	...	32	27.8	
Baltimore	—5	111.0	5.7	0.2	14.5	2.7	5.2	125.5	8.4
Canton	84	....	...	0.5	....	...	83.5	....	
Columbus	56	85.0	...	1.7	6.5	...	54.3	91.5	
Fitchburg	59	75.0	—1.0	0.3	22.7	2.7	58.7	97.7	1.7
Lexington	57	....		0.1	....	...	56.9	....	
Reading	...	76.0	5.0	...	16.5	1.8	...	92.5	6.8
Rochester-Brighton	31	28.9	1.9	3.7	15.4	0.9	27.3	44.3	2.8
Rochester-Irondequoit	26	....	...	0.9	....	...	25.1	....	
Averages	...	....	...	...	....	...	39.3	73.2	4.9
Comparative efficiency, per cent	...	....	...	...	....	...	33.5	62.3	4.2

"settling tank effluent" and "filter effluent." This difference averages about 80 p.p.m.

The curves shown in Fig. 4 give the relation between the reduction in the bio-chemical oxygen demand when the sewage has been treated by settling tanks, trickling filters, and humus tanks and the corresponding reduc-

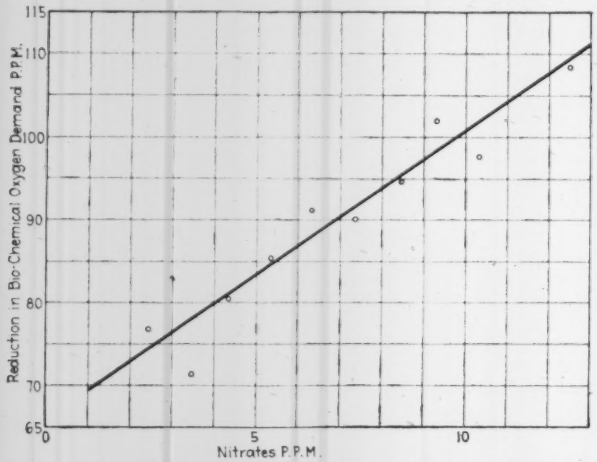
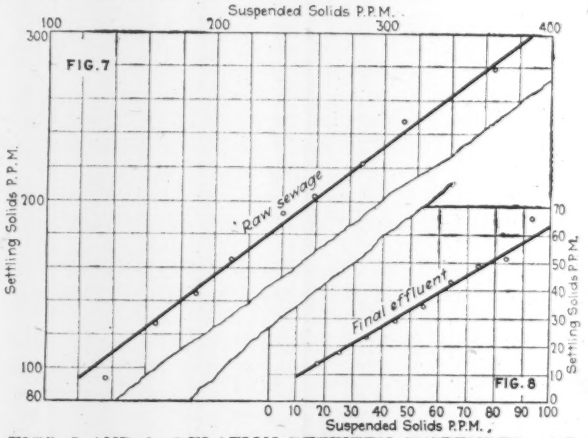


FIG. 6—RELATION BETWEEN REDUCTION IN BIO-CHEMICAL OXYGEN DEMAND BY TRICKLING FILTERS AND NITRATE PRODUCTION, 1913-25

tion in solids. With a reduction in settling solids from 40 to 240 p.p.m. by the sedimentation tanks, the corresponding reduction in the oxygen demand varies from 52 to 90 p.p.m. One point that seems worthy of emphasizing is the important role which settling tanks play in reducing the oxygen demand. When the curves marked "Reduction by settling tanks" and "Reduction by settling tanks and trickling filters" are compared, it is apparent that the settling tanks lower the oxygen demand about as much as the trickling filters. Not infrequently these amounts are expressed in percentages, and unless care is used in interpreting them incorrect conclusions will be drawn. From 1919 to 1925, the settling tanks at Baltimore reduced the oxygen demand from 174 to 104 p.p.m., or 40 per cent, and the trickling filters from 104 to 29 p.p.m., or 72 per cent. However, the reduction by the former method when expressed in parts per million was 70 and by the latter method 75. It is thus apparent that the real basis of comparison should be a quantative rather than a percentage reduction.

In this connection Fig. 5 has been prepared to show the reduction in the oxygen demand by the settling tanks, trickling filters, and humus tanks at the Baltimore works for 1919-25. This percentage reduction is the ratio of the decrease of the oxygen demand of the sewage as it passes through each treatment unit to the total oxygen demand of the raw sewage. The diagram is comparable with a heat balance diagram used in power plants to account for all of the heat in coal. As shown on the diagram, 40.3 per cent of the oxygen demand is removed by the settling tanks, 43 per cent by the trickling filters, and 0.2 per cent by the humus tanks. The diagram is not intended to give a complete and comparative picture of the role played by the three treatment units in purifying the sewage. The trickling filters are considerably more efficacious than the settling tanks in that large volumes of dissolved and nitrate oxygen are added to the sewage.



FIGS. 7 AND 8—RELATION BETWEEN SUSPENDED AND SETTLING SOLIDS, RAW AND SETTLED SEWAGE, 1922-25

Table II, which has been prepared from the data in "U. S. Public Health Bulletin No. 132," shows the comparative efficiencies of settling tanks, trickling filters, and humus tanks at eleven sewage-works. The reduction of the 5-day oxygen demand is the difference between the oxygen demand of the influents and the effluents of these units. The change in the oxygen content in the case of the settling tanks is the decrease in the dissolved oxygen as the sewage flows through these tanks, and in the case of the trickling filters and humus tanks is the increase of dissolved and nitrate oxygen. As the oxygen in the raw sewage in nitrates and nitrites is small or totally absent, it has not been included. For the same reason the dissolved oxygen in the settled effluent and the nitrite oxygen in the filtered sewage and the humus tank effluent has been neglected. The oxidizing power of the three types of units is the algebraic sum of the reduction of the oxygen demand and the change in the oxygen. This study shows that the com-

parative efficiencies of the settling tanks, trickling filters, and humus tanks are respectively 33.5, 62.3 and 4.2 per cent. Trickling filters are about twice as instrumental as settling tanks in treating the sewage, and the role played by humus tanks is comparatively small. As is shown by Fig. 4 the total reduction in the oxygen demand after the sewage has passed through the humus tanks is less than when it leaves the trickling filters. This condition is true only when the reduction in settling solids is less than 140 p.p.m. When the reduction is greater than this amount, the humus tanks are instrumental in reducing the oxygen demand.

Fig. 6 is of interest in that it shows the relation between the reduction in the bio-chemical oxygen demand of sewage treated by trickling filters and the corresponding increase in the nitrate nitrogen. When individual samples are studied, a high nitrate production may coincide with a low reduction in oxygen demand, but a study of several hundred analyses has made it clear that there is a general relation between the two sets of analyses.

Figs. 7 and 8 give the relation between the suspended and settling solids in the raw sewage and the final effluent. These graphs show the physical change which has taken place in the sewage after it has been treated. A steep curve indicates a sewage with a small percentage of non-settling and colloidal matter present, while a flat curve shows the opposite, as in Fig. 8.

The Baltimore sewage-works is under the general supervision of B. L. Crozier, chief engineer of the city, and M. J. Ruark, sewerage engineer.

Detour News Officially Reported by Ohio Newspapers

By H. E. Neal
Chief, Traffic Bureau, Division of Highways, Columbus, Ohio

For several years a weekly detour bulletin has been issued by the Ohio highway department during the construction season. This bulletin in the beginning was mimeographed and distributed to motor clubs and other organizations interested. Later a blueprint map was issued with the bulletin. The response to the bulletin was so great that it was necessary to increase the circulation greatly. Accordingly, the map and bulletin were combined and printed. However, the demand became so great that the department was unable to comply with all requests and it became necessary either to limit the distribution to a selected list or to publish in some general medium; the latter was done.

At the beginning of the present season arrangements were made with the *Ohio State Journal* for the publication of the bulletin and map. This journal in turn makes and furnishes plates for printing the bulletin to twelve other newspapers in the leading cities of the state. All these newspapers print the bulletin on Friday of each week.

The bulletin is compiled by the highway department from weekly detour reports on standard forms sent in by the resident engineers of each of the 88 counties. These reports are required to be prepared on Saturday of each week and are mailed by the resident engineer to the division engineer's office where they are checked and then forwarded to the central office by special delivery. All reports are required to be in the central office not later than Tuesday evening of each week.

Each resident engineer is required to anticipate the establishment of new detours and the removal of detours and not to wait until a road is actually closed, or a detour removed, before making out a report. This applies particularly to detours which will be established or removed after the publication of one week's bulletin and before the publication of the next. In special cases the resident engineer reports directly to the central office either by telephone or telegram.

The complete detour bulletin consists of a map of the state highway system upon which the sections of road closed to traffic are indicated by wide lines. Printed outside the margin of the map is a list of all detours, arranged alphabetically by counties. This list states the length of the new improvement, the type of pavement being built, the type and condition of roads comprising the detour and the total length of the detour.

Dolgarrog Dam Failure Blamed on Poor Foundation and Concrete

In A report on the Dolgarrog dam break disaster in North Wales, which occurred on Nov. 2, 1925 (see *Engineering News-Record*, Jan. 7, 1926, p. 12), Sir Alexander Gibb & Partners, consulting engineers, declare that the foundations were not carried deep enough and that the concrete was of poor quality and was not watertight. The report is abstracted in the *London Times* of Oct. 2.

Lake Eigiau dam, the structure whose failure caused the flooding of the town of Dolgarrog, had a storage capacity of 160 million cu.ft. The dam was built at a point where the soil consists of glacial clay overlain by a bed of peat. The consulting engineers say that the section of the concrete dam is sufficient for stability, but that the spillway and freeboard are not adequate. However, as to the foundations, they say:

"The foundations of the concrete wall are not, in general, carried deep enough to form an effective cutoff. The concrete is generally of poor quality and is not watertight."

Farther on, they say that had the Eigiau dam been built throughout of good concrete in accordance with the typical section and with the base of concrete taken to a minimum depth of 6 ft. into the clay, it is probable that the wall would have remained quite satisfactory and that the disaster would not have occurred. At the point of the breach, in test pits and at exposed surfaces of the concrete, the concrete is seen to be generally poor and in places very bad; the workmanship in placing the concrete was not satisfactory, and an excessive quantity of large stone displacers was used, and these stones were carelessly placed.

Proposals for reconstruction of this reservoir, which the consulting engineers approve, include strengthening of the existing wall concrete by cement grouting under pressure, reconstructing the failed portion in concrete, providing reinforced-concrete facing and a watertight concrete cutoff wall along the whole length, providing a new spillway, and enlarging and concrete-paving the north embankment.

In connection with their comments on this dam, the consulting engineers also discuss the lower dam, called the Coety dam, which was breached by the flood coming down from Lake Eigiau; and three other dams in the vicinity (Cowlyd, Llugwy, and Lake Llydaw dams) which, however, were not involved in last year's failure.

Modern Bridge in Parkway System of Cleveland, Ohio

Long-Span Concrete Arches Built with Four Ribs in Order to Carry Wide Roadway—Old Centers Reused

By A. M. Felgate

CUYAHOGA COUNTY recently completed another highway bridge across Rocky River gorge in which certain interesting features of traffic, esthetics and construction were involved. The bridge forms a link in a main road to the west, and will attract much traffic; for this reason it was made unusually wide. Located in

FIG. 1—STEEL CENTERS OF 170-FT. SPANS REUSED TO SUPPORT 220-FT. ARCH RIBS

a parked area, it required careful consideration of lay-out and proportioning to obtain good esthetic effect. It was built upon centering which the contractor had used for another structure having smaller spans, and the centers were ingeniously adapted for service under these conditions.

Rocky River gorge, seven miles west of the Public Square, Cleveland's center, has heretofore been crossed by only two bridges. Traffic growth in recent years crowded these to capacity, and the need for a third crossing became imperative. Authorization to built it was obtained late in 1923, a bond issue of $930,000 being voted. The bridge was opened to traffic last December, 19 months after letting the contract.

The new crossing is on the line of Hilliard Road, and is 900 ft. long. Deck level is 125 ft. above the valley bottom. For the desired traffic capacity a 56-ft. roadway is provided in a total deck width of 80 ft.

The valley is part of the park system of the city of Cleveland. For this reason a three-span design was chosen, the vista through a central arch being considered desirable. The central arch is 220 ft. long center to center of piers, while the two outside arches are 196 ft. each. In order that the bridge might appear lighter, the distance from the grade to the crown of each arch was made as short as possible. In addition, a sharp batter was used on the piers, to make them narrow at the top but wide enough at the base to withstand unbalanced loading during construction. At each abutment there is an ornamental concrete pylon, through which an arched passage leads to a balcony. This affords a view of the side of the bridge and an extensive prospect of the river below.

The roadway has a constant up grade to the east of 0.5 per cent. It is surfaced with brick laid with an asphalt filler. Provision has been made for double street-car tracks by leaving a depression which is temporarily filled with cinder concrete and paved over.

The extreme width of roadway and the fact that provision had to be made for street cars made it advisable to use four arch ribs in a span. The outer ribs are

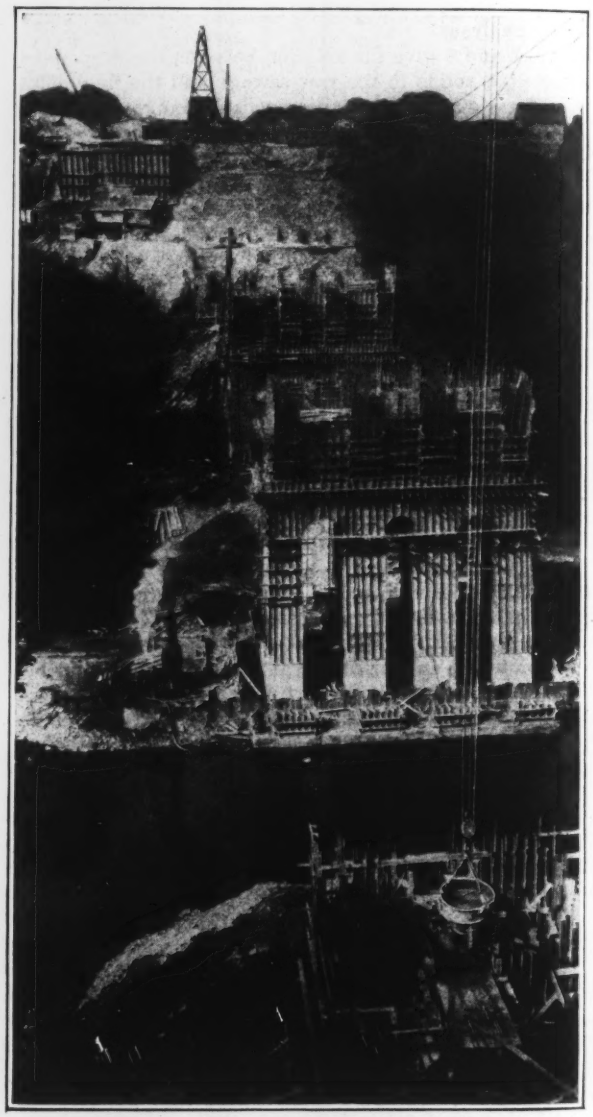


FIG. 2—A, 1,200-FT. CABLEWAY DISTRIBUTED MATERIALS, BRINGING THE CONCRETE FROM THE MIXING PLANT (LEFT BACKGROUND)

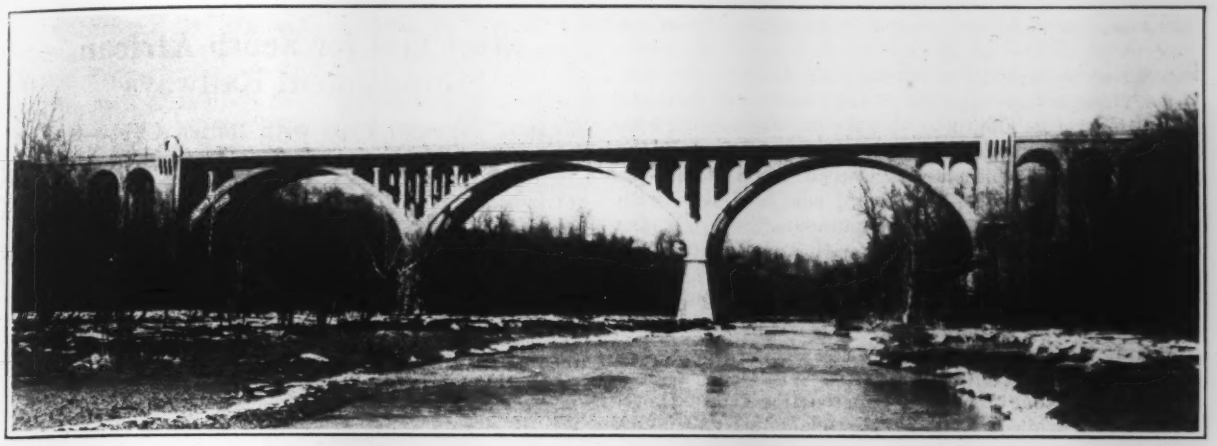


FIG. 3—ROCKY RIVER WINDING BENEATH THE ARCHES OF HILLIARD ROAD BRIDGE

6 ft. wide while the inner ones, which carry the tracks, have a width of 8 ft. Their thickness varies from 9½ ft. at the springing line to 4½ ft. at the crown.

The floor of the bridge consists of concrete slab, spanning longitudinally between floorbeams 11 ft. apart. Over the crown of the arches these floorbeams rest upon 2½-ft. longitudinal spandrel walls which have extra reinforcement beneath each panel point, forming virtually a series of posts supporting the floorbeams. At a distance from the arch crown a series of 22-ft. spandrel arches carrying two panels apiece supports the deck.

The handrail, of Amherst sandstone, is composed of square balusters. This shape, which does not require lathe work, was less expensive than the circular sections and produced a balustrade to harmonize architecturally with the concrete pylons at the abutments.

Ample provision is made for temperature changes. The entire floor system is articulated. Double floor-

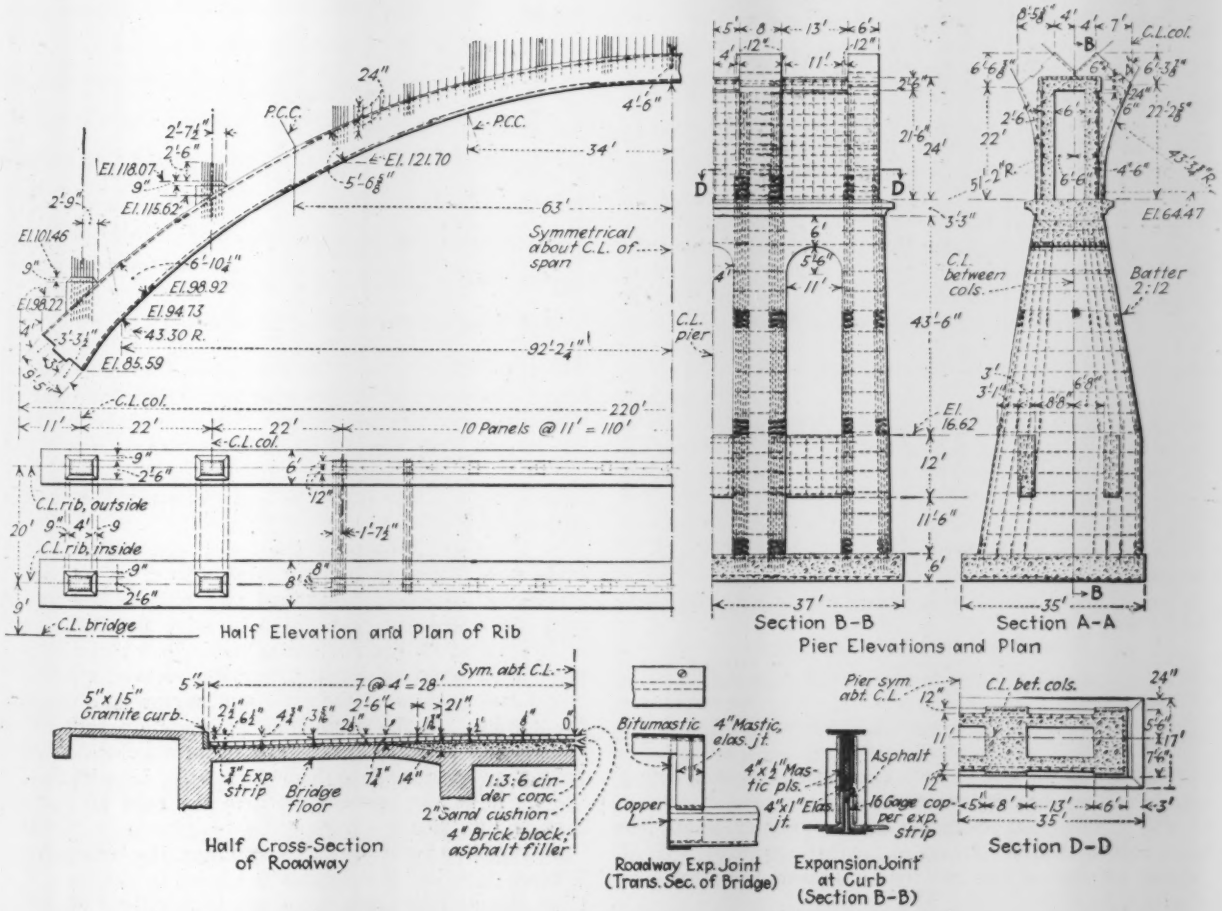

Half Elevation and Plan of Rib
Section B-B
Section A-A
Pier Elevations and Plan
Half Cross-Section of Roadway
Roadway Exp. Joint (Trans. Sec. of Bridge)
Expansion Joint at Curb (Section B-B)
Section D-D

FIG. 4—PIER, RIB, AND ROADWAY SECTIONS OF HILLIARD ROAD BRIDGE

beams separated by an expansion joint are located at the crowns of the first jack arches in front of the abutments and at the crowns of the jack arches over each pier. These arches are split at the center and designed as cantilevers to eliminate the use of sliding surfaces. On the pavement 6x6-in. angles are placed to retain the paving brick. The distance between the upright legs of the angles, which is almost an inch, is flashed with sheet copper to retain the bituminous filler. On the sidewalk the opening is covered with a sheet lead strip fastened to angles built into the slab.

The roadway surface is waterproofed by the membrane method. Drainage is taken care of by catchbasins placed at intervals of about 200 ft., discharging to the river through spouts in the piers.

The contractor, the Walsh Construction Co. of Cleveland, had previously built a railroad bridge at Sidney, Ohio, 150 miles from Cleveland, and the steel centers used in this construction were still available. They were three-hinged arches built for spans of 170 ft. By the use of auxiliary towers at either end, and wooden framing over the steel the centers were enlarged to fit the longer span and different arch curve of the present job.

The ribs were poured in pairs. After one pair had been poured the centers were moved transversely with the aid of jacks until they were in position for the other two ribs. The arch concrete was poured monolithically. The superstructure was placed by loading all crowns first and then pouring the balance symmetrically to insure minimum distortion of the piers. Careful measurements were taken of the horizontal deflection of the piers at the springing line, and it was found that ½ in. was the largest strain caused by the loading system. As the loading became balanced this strain was eliminated and the piers are now within ⅜ in. of their theoretical position.

The design of the mixing plant was governed by the source of supply of the raw material. Local conditions and freight delivery made the west bank of the river the logical location for the mixers, and the adoption of a traveling cableway with an 80-ft. travel spanning the 1,200 ft. across the valley, provided a means of delivering materials and erecting the centers and forms. All concrete was mixed by two machines, fed by gravity from bins built on the sloping west bank. These bins had a capacity of 1,200 cu.yd. and were filled by trucks discharging from the top of the bank. The coarse aggregates and sand flowed by gravity into measuring hoppers, which were regulated by the county inspectors. The concrete discharged into 2½-yd. buckets with drop-bottoms. The plant turned out regularly 30 cu.yd. of concrete per hour.

The quantities and unit prices for this bridge were as follows:

Concrete beams, slabs, columns, and walls	11,200 cu.yd. at	$26.70
Concrete in arch ribs	3,830 cu.yd. at	37.00
Concrete in footings	1,395 cu.yd. at	17.40
Concrete in piers and abutments	8,230 cu.yd. at	19.50
Reinforcing steel	740 tons at	80.00

The prices do not include excavation, waterproofing, catch basins, lighting conduits, etc.

The bridge was designed by the writer under the direction of Frank R. Lander, county engineer. W. H. Baker served as the resident engineer for Cuyahoga County.

Steel Ties for South African Government Railways

"Peapod" Trough Type with Bolted Clips—Special Gage Adjustment, Rail Anchors and Guard Rail Device

TRIALS of a new design of steel tie on four of the main lines of the South African Government Railways are noted in the annual report of Sir W. W. Hoy, general manager of railways and harbors, and this design is shown in the accompanying drawings. All these lines are of 3 ft. 6 in. gage.

The ties are of the pressed-steel trough type, combining features of the Post and Rendel designs. The former was used at one time on the Netherlands State Railways and also, many years ago, on the railways of the Transvaal (then the South African Republic), which were owned by a Netherlands or Dutch company. The Rendel tie is used extensively in India and the British colonies, but usually with wedge or tapered key fastenings for the rails. Special features of the new ties are the arrangements for adjusting gage, giving superelevation on curves and anchoring the rails against

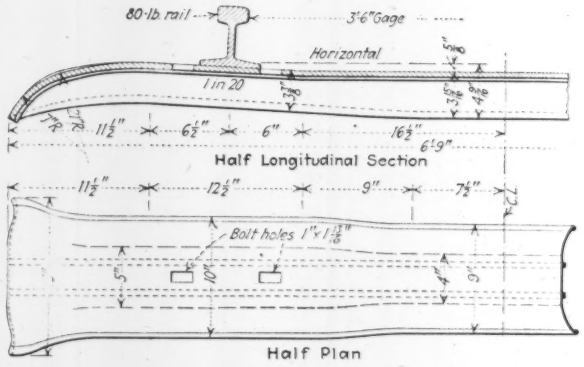


FIG. 1—PRESSED STEEL TIES FOR SOUTH AFRICA

creeping. Fig. 1 shows the general design for use with 80-lb. T-rails of the British standard section, and Fig. 2 gives details of the fastenings. A lighter design is used for branch lines having 60-lb. rails. There are 2,112 steel ties per mile on main tracks and 1,760 to 2,080 on branch lines. Lists of weights are given in the accompanying table.

In the manufacture of the tie, a flat plate is first rolled to a thickness varying from ½ to ⅝ in. and reinforced by thickened edges and two ribs on the under side. As rolled, the plate is 13 in. wide and 7 ft. long, or 12 in. x 6½ ft. for the lighter ties. This plate is then pressed to a trough form of varying section, relatively broad and shallow at the ends and narrow and deep at the middle. At the same time the ends are bent down and splayed outward at the sides to form a closed trough having an extreme length of 6 ft. 9 in. Longitudinally the tie is so cambered as to give the rails an inward cant of 1 in 20.

Bolted clips form the rail fastenings, the bolts having T-heads inserted through slotted holes in the tie. The clips also fit into these holes and thus relieve the bolts

from some of the lateral pressure. A spring washer is placed between the clip and the nut. To provide for widening gage on curves, three sizes of clips are used, having widths of $\frac{13}{32}$, $\frac{15}{32}$ and $\frac{17}{32}$ in. between the bolt and the back of the bolt hole. With different combinations of the four clips to each tie, six widths of gage can be given, from the standard gage of 3 ft. 6 in. to a maximum of 3 ft. $6\frac{4}{8}$ in.

For sharp curves, where a guard rail is required for the outer track rail, both rails are seated on a rolled base plate which is so shaped as to give the guard rail an outward cant toward the track rail. In this way, thrust against the guard rail is transmitted in part to the tie. In addition, a pressed-steel rail brace is applied, secured by a bolt and held up to its work by a lip on the edge of the base plate. This rail brace grips the outer edge of the base of the guard rail. Two bolts with ordinary and special clips form the other attachments.

To prevent creeping, the rails are gripped by horizontal wedges, as shown in Fig. 2, this device being used in sufficient numbers to meet varying requirements. Where these anchor fastenings are used, the rail does not rest directly upon the tie, but on a rolled or cast base plate, the outer end of which is held by a track bolt, while the inner end has a hooked lug entering a slotted hole in the tie. A top lug on the outer end of this plate holds the edge of the rail base, while on the inner end is a heavier lug shaped to fit a horizontal steel wedge or tapered split key, $8\frac{3}{4}$ in. long, which is driven between the lug and the rail. It will be seen that the bottom face of the wedge is shaped to bear against both the top and side of the rail base. This anti-creeping device and the guard-rail attachment are experimental. If the former does not prove satisfactory, a rail anchor may be substituted for it.

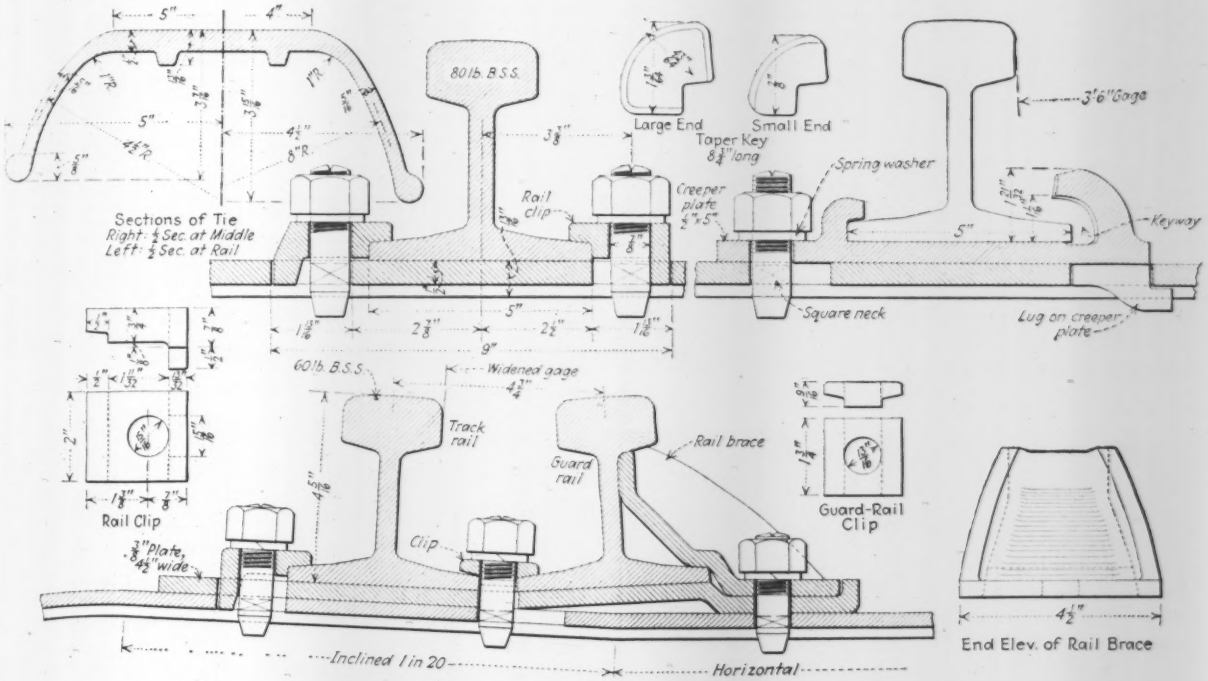


FIG. 2—FASTENINGS AND RAIL ANCHORS

WEIGHTS OF STEEL TIES: SOUTH AFRICAN RAILWAYS

	For 80-lb. Rails		For 60-lb. Rails	
	Unit Lb.	Total Lb.	Unit Lb.	Total Lb.
Tie (1)	134.5	134.500	87.75	87.750
Gage clips (4)	0.824 to 0.96	3.568	0.512 to 0.563	2.150
Bolt, nut and washer (4)	1.057	4.228	0.662	2.648
Total; ordinary tie on tangent		142.296		92.548
Creep chair (2)	10.37	20.740		
Tapered key (2)	1.59	3.180		
Total; tie on curve*		166.216		

*Minus four gage clips and two bolt fastenings, 5.682 lb.

In regard to wood ties, the report states that while the use of native timber is encouraged there is difficulty in obtaining an adequate supply of suitable timber. The railway administration has 58,570 acres of land for tie plantations, with 28,570 acres already planted with eucalyptus and pine.

These steel ties were designed and installed under the direction of R. C. Wallace, chief civil engineer, South African Railways and Harbors.

Progress on Ohio River Dams

At the recent meeting of the Ohio Valley Improvement Association, at Paducah, Ky., a statement as to the lower dams and locks for 9-ft. slackwater navigation on the Ohio River was made by Col. C. R. Spalding, Corps of Engineers, U. S. A. Dam 45 is to be completed in 1926; dams 46, 47 and 49 in 1927; dams 41, 50 and 52 in 1928; and dams 51 and 53 in 1929. Dam No. 42 has been eliminated and dams 43, 44 and 48 are completed.

From Job and Office

HINTS THAT CUT COST AND TIME FOR THE CONTRACTOR AND ENGINEER

Derrick Attached to Building Column by Special Seating Casting

IN HANDLING cut stone for the facing of the Graybar Building, 43rd St. & Lexington Ave., New York City, derricks were used which economized greatly on setup space. Two of these derricks were erected, one at each line of the steel column on the court corners of the Lexington Avenue side, and erection preceded any masonry placement.

The derrick was supported to the street face of the column by a special U-shaped casting of 1½-in. iron held to the column just above the gusset at the third story level by three 1½-in. bolts passing through a 1-in. cast-iron plate 14 in. wide and 30 in. long, placed flat against the back of the column. The column was protected by wales which, wedged securely by tightening the bolts, gave the derrick a friction seating on the column. The street side of this derrick seat, U-shaped in side elevation and triangular in plan, was reinforced by two 14-in. channels placed back to back, but which did not extend

LEFT—DERRICK ERECTED ON BUILDING COLUMN—RIGHT—SPECIAL SHOE OF HEAVY CAST IRON

the entire length of the flanges in the casting. In the vertex of each flange was a hole to take the 3-in. pin which held the derrick shoe to the seat. The shoe was a special casting of 1½-in. cast iron. The derrick load and fall lines passed through a pulley attached higher onto the column by special castings practically the same as those which supported the boom, though of smaller dimension.

With the derrick at the third story level, all cut stone was handled from trucks, either to its place in the wall or stockpiles for use as needed.

The cut stone contractor who devised the derrick seating was Dickson & Trumbull.

Track Castings for Rolling-Lift Bascule Bridges

THE latest design of track and tread castings for the rolling segments of bascule bridges of the Scherzer rolling-lift type is shown in the accompanying

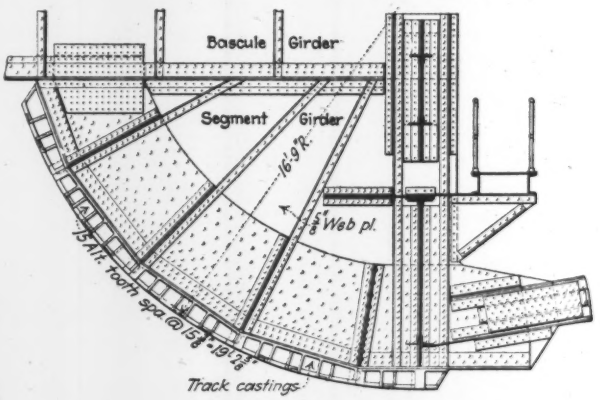


FIG. 1—HEEL OF ROLLING-LIFT BRIDGE

drawings, which represent these parts for the Arrowhead 240-ft. double-leaf bascule bridge now being built for a new highway between the cities of Duluth, Minn., and Superior, Wis.

In the earlier designs of bascule bridges of the Scherzer type, the bottom chords of the segmental girders were shaped to the desired radius and covered with heavy plates forming the rolling heel. Similar plates were placed on the top chords of the fixed track girders, forming treads on which the curved heels of the bascule span traveled. This construction developed defects due to the intensive loads, the movement of these loads and the racking strains thus caused in the built-up members with consequent wear and deformation. Furthermore, it was difficult to build these parts of structural steel of such strength as to resist the distortion under heavy rolling loads. These conditions, together with methods of repair and reinforcement used on certain bridges, were reviewed in *Engineering News-Record* of March 9, 1922, p. 414, and in the *Journal* of the Western Society of Engineers for 1924, p. 187; also in the *Proceedings* of the American Railway Engineering Association for 1926, p. 1259. To eliminate these troubles in the newer bridges, steel castings were substituted for the rolled steel track and tread plates, these castings being of such depth and so designed as to serve as pedestals in distributing the pressure to the supporting structural steel girders.

In the Arrowhead bridge, each leaf will weigh about 572 tons, including the counterweight, which entire load is rolled back and forth on the track girders. It will be

seen that the structural design of the segmental girder is simplified by abandoning all attempt at a curved periphery. This girder, as shown in Fig. 1, has a polygonal face to each side of which is bolted a steel casting whose outer or rolling surface has a radius of 16 ft. 9 in. Recesses spaced 15¾ in. c. to c. are formed to engage the teeth of the horizontal rack on the track

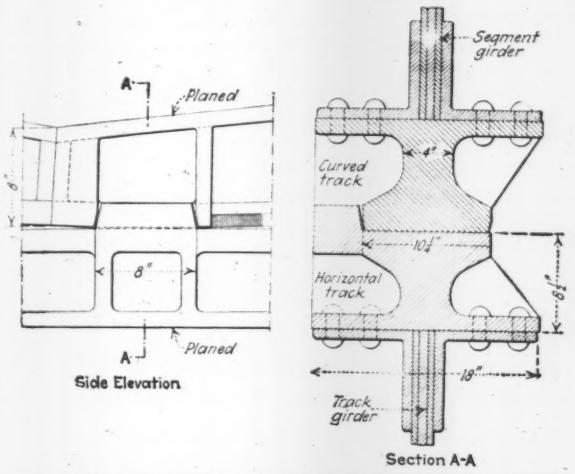


FIG. 2—TRACK CASTINGS FOR ROLLING-LIFT BRIDGE

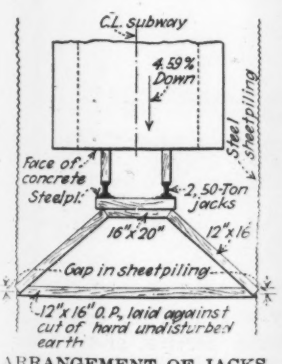
girder. The length of rolling surface is 20 ft. 6 in., the span moving through an arc of about 70 deg. and rolling back horizontally about 20 ft.

From the detail drawing, Fig. 2, it will be seen that the minimum thickness of the castings is 8 in., while the width of contact bearing is 10¼ in. The castings on the segmental girder are provided with teeth that mesh with lugs on the track-girder castings, and thus prevent both longitudinal creeping and lateral displacement. This bascule bridge, owned by the Arrowhead Bridge Co., Superior, Wis., was designed by the Scherzer Rolling-Lift Bridge Co., Chicago, and is being built by the American Bridge Co.

Concrete Approach to Subway Slides 6 In. on Asphalt Waterproofing

By Ned D. Baker
Office Engineer, Estuary Subway Project, Oakland, Calif.

IN POURING the north-shore end of the subway under the Oakland estuary at Oakland, Calif., an unforeseen problem arose when the heat generated by the chemical action of the concrete in setting softened the asphalt waterproofing under the concrete. On the surface that was thus lubricated a portion of the invert that had just been poured moved slowly downgrade a total of 6 in. It was stopped and held by an arrangement of jacks without any harm to the structure and a change in design prevented any further trouble in sections poured later.

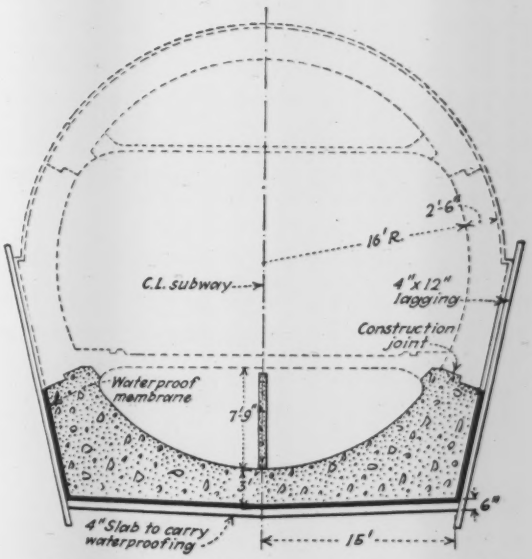


ARRANGEMENT OF JACKS THAT STOPPED SLIDING

The point at which the sliding occurred is on the Oakland side where the subway has an inclosed section of horseshoe shape and is built on a 4.59 per cent grade. Here the entire structure is surrounded by an envelope of waterproofing consisting of three layers of cotton fabric with moppings of hot asphalt under, between and over them. When the excavation for this portion of the work was completed a 4-in. slab of concrete was poured on the subgrade to serve as a base for the membrane waterproofing placed upon it. The waterproofing was carried up the sides on 4x12-in. timber lagging, as shown in the accompanying sketch.

For the convenience of the steel workers the sub-base was held 1 in. low and the waterproofing was covered with an inch of mortar. On this the steel cage was built in place and the concrete of the invert was poured up to the first construction joint. The waterproofing specifications called for a minimum of one-third of a gallon of hot asphalt per square yard of surface for each of the four moppings and when finished the membrane was about ⅜ in. thick.

The concrete invert poured on top of this membrane varied from 3 ft. thick at the center to a maximum at the outer corners of nearly 8 ft. measured radially;



TRANSVERSE SECTION OF SUBWAY SHOWING SLIDING PLANE

and averaged about 8 cu.yd. per lineal foot. The pouring of concrete in the first segment of this invert was started on the morning of March 26 and when the work was stopped, Saturday evening, March 27, a total of 500 cu.yd. or about 1,000 tons had been put in.

On Monday, March 29, rough measurements showed that this entire mass had moved downgrade about 2 in. The heat of setting, especially near the bottom, had been confined to the vicinity of the asphalt waterproofing which had been softened, forming a lubricant on a 4.59 per cent skidway. Accurate points were then set and daily observations begun which showed continuous movement, running from ¾ to ½ in. daily up to April 3. On that date the sliding was stopped by the arrangement of jacks and struts to the sheetpiling shown in the sketch. The jacks were used merely to take up all slack in the joints and any "give" there was in the abutments, thus making a snug fit for the transfer of

stress from concrete to abutments. The gap in the sheetpiling just happened to be there and hence was used as a convenient footing against which to brace.

The longitudinal steel in this part of the structure consists of 158 bars of ¾-in. square steel spaced on 6-in. centers along both faces. Thus there was ample strength to hold this pour firmly to the previously completed work above and thus to prevent further sliding as soon as the concrete had set enough to develop bond.

Subsequent work was safeguarded by building corrugations across the concrete sub-base slab. This proved to be entirely adequate and no movement was detected along the waterproofing plane in any of the later work.

Since the 6-in. sliding movement was directly along line and grade no harm was done excepting only the anxiety caused the engineers and the contractor's force until the movement was entirely stopped.

The method of stopping the movement was devised by Bayly Hipkins, than manager of construction for the contractors, the California Bridge and Tunnel Co.

Electric Saw Saves Time in Fitting Roof Sheathing

THE roof of the Southern Pacific Co.'s oil reservoir recently completed at Tracy, Calif., covers an area of 14 acres and is finished off on top with a sheathing of 1-in. boards overlain by resin-sized paper and 3-ply asbestos roofing. A considerable part of the work of placing the sheathing was in cutting and fitting the ends of the boards to get a good joint at the center of

ELECTRIC HAND SAW, TRIMMING SHEATHING ON 14-ACRE ROOF

the 2x8-in. rafters on which they were supported. An electric saw on a small truck was first tried but was replaced by the motor-driven hand saw shown in the accompanying picture. This saw was well adapted to the work and rapid progress was made by use of the method described here.

The boards used for this sheathing were in 6- and 8-in. widths and were laid on the rafters with both ends extending beyond the center lines of the rafters on which the joints were to be made. That is, a rafter on which the sheathing joint was to be made would have the ends of both boards laid on it, one layer resting on the other, with their ends overlapping slightly beyond the center line.

Only 8 joints in 6-in. boards or six joints in 8-in. boards were allowed at one rafter, the next lot making joints at the next rafter, and so on. A mark was then made on the overlapping boards to show the rafter center line across the group of six or eight boards, as the case happened to be.

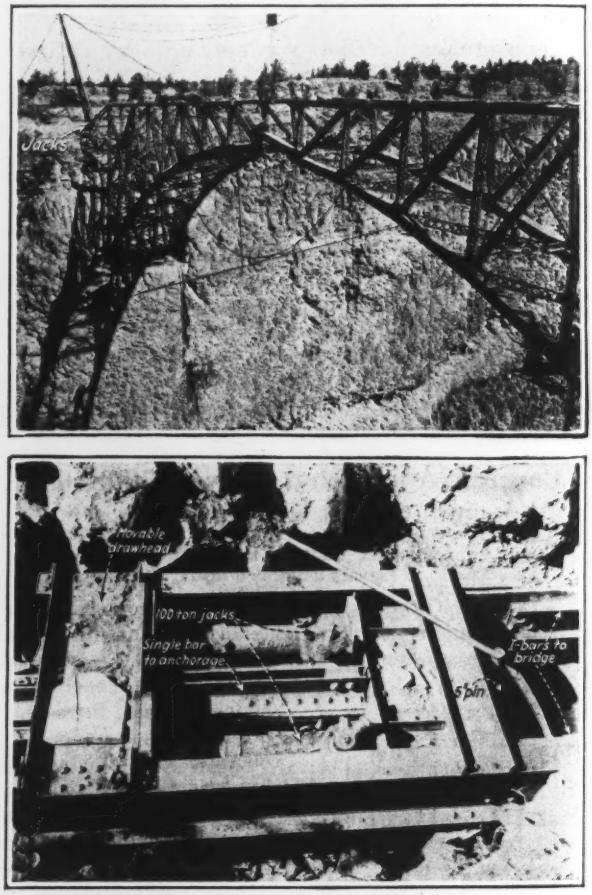
The next step was to cut the boards on this line. This was done to good advantage with the hand saw shown in the picture, by setting the shoe so that the projection of the rotary saw would just extend through the two boards without cutting into the rafter supporting them.

From Job and Office

HINTS THAT CUT COST AND TIME

Jacks in Tie-Back Aid Final Closure in Steel-Arch Bridge

IN THE erection of the steel-arch highway bridge over the Crooked River in Jefferson County, Ore.,



PLACING CROWN PANEL FROM CABLEWAY, AND DETAIL OF THE JACK NEST

a structure which required 518 tons of steel and has a span of 331 ft., a cableway was used for construction in place of the usual traveling derrick, and a pair of jacks at each end of each truss served to control the

From Job and Office

FOR CONTRACTOR AND ENGINEER

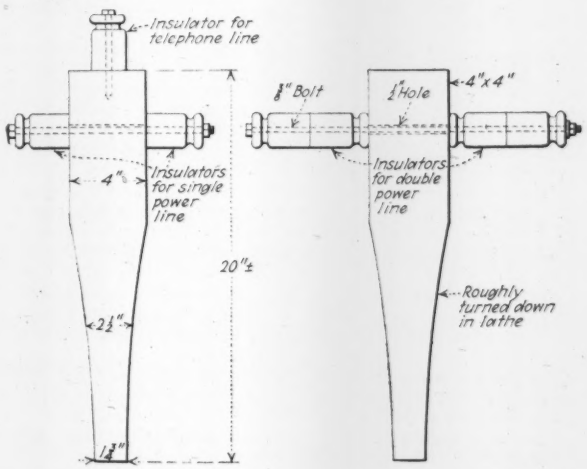
elevation at the crown so that the pin connection in the arch was easily made.

The bridge was constructed by the cantilever method, each truss being fastened to a concrete anchorage by a tie-back of I-bars. In order to adjust the length of these I-bars conveniently while under the stress of full dead-load pull, each one was provided with a pair of 100-ton ratchet jacks. These jacks were arranged within a structural-steel framework in such a way that extending the jacks would shorten the tie-back and raise the truss it supported. Details of this steel frame are shown in *Engineering News-Record*, May 13, 1926, p. 761. With this arrangement the closure was quickly and satisfactorily made.

Booth & Pomeroy, Inc., Portland, were the contractors.

Convenient Wood Spuds for Carrying Power Wires in Tunnel

IN THE 8-mile Great Northern Ry. tunnel now being driven in Washington which has thus far traversed rock exclusively, 220-v. power wires are carried on wood spuds driven into holes drilled for the purpose 8 or 10 in. deep in side walls or roof. The spuds are made



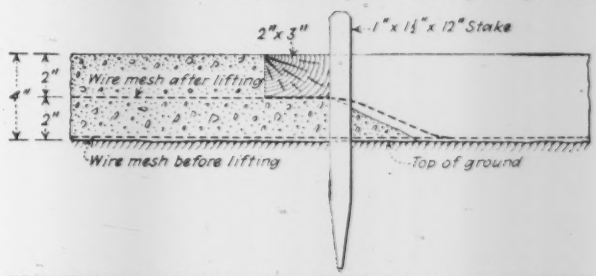
SPUDS FOR POWER WIRES IN TUNNEL CONSTRUCTION MADE FROM 4 X 4-IN. LUMBER

up in large quantities from short pieces of 4x4's, usually about 20 in. long, one end of which is turned down in a lathe to a diameter that will readily go into 2½-in. drill holes. The taper gives a good tight fit that holds the spud firmly in place.

A hole is bored through the spur near the large end in which is inserted a bolt long enough to extend entirely through the spud and clamp to it two insulators for carrying the wires. Where two pairs of wires have to be carried on one spud two insulators are used on each side, as shown in the sketch, held in place by a longer bolt. Sometimes still another insulator is spiked to the end of the spud for carrying a pair of telephone wires.

Offset Joint for Concrete Pavement in Oil-Storage Reservoirs

THE western practice in building reservoirs for oil storage is to use no contraction joints in concrete pavement even when very large areas are paved. A reservoir recently built near Tracy, Calif., has an area of over 14 acres without any contraction joints in the paving. Care is taken to protect the paving from



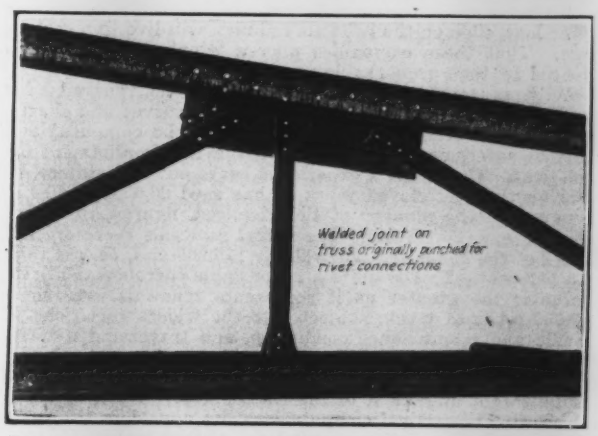
CONSTRUCTION JOINT FOR PAVEMENT IN OIL RESERVOIR

extreme temperature changes until oil is put in, after which no material temperature variation is expected. In the Tracy reservoir the pavement was poured in successive strips, and joints between strips were made as shown in the accompanying illustration.

The design of this joint is intended to avoid a vertical plane of weakness directly through the slab such as would probably result from the use of full header boards of standard type. In addition to forming an offset for the joint the 2x3 nailed to the stake at the right height above the ground serves as a guide to indicate the proper height of the mesh as it is pulled up into position in the concrete slab. After this offset header is removed in preparation for the next pour, which usually follows very soon, the edges of the joint are painted with grout to facilitate bond.

Job and Office Notes

Although Designed and Punched for Riveting, some roof trusses used at the Modern Power Device Co., Port Washington, Wis., were finally welded at the instance of the engineer in charge. It is said that the use of one welding



operator permitted the release of a riveting gang of three men and completion of the job in less time than originally had been estimated. It was calculated that the welded joint would give approximately 40 per cent more strength than would be attained with riveting. Arc-welding equipment of the Lincoln Electric Co. Cleveland was used and this company has supplied the above information.

Letters to the Editor

A FORUM FOR DISCUSSION OF VIEWS OF ENGINEERS AND CONTRACTORS

From State Engineer to Governor

Sir—All engineers must appreciate highly your kind notice of the election of Mr. Emerson as governor of Wyoming. In saying that Mr. Emerson is the first civil engineer governor I think that an error has been made.

The late Emmet D. Boyle was some years ago state engineer of Nevada and from that position was elected governor of Nevada. While I was not familiar with Mr. Boyle's training and education I know that he served the state well, both as state engineer and governor.

It might not be amiss to point out that the present governor of Utah, George H. Dern, is a trained engineer of high attainments in mining and metallurgical engineering.

The governor of Nevada, Mr. Scrugham, who has just been defeated for re-election, is a mechanical engineer, and had been successively dean of engineering at the University of Nevada and state engineer under Governor Boyle.

Salt Lake City, Utah, Nov. 15, 1926. GEORGE M. BACON, State Engineer.

[There is, of course, a distinction more or less without a difference between the civil and the mechanical and the mining engineer where the broader problems of engineering are concerned, but the point made in the editorial was, so far as our record shows, that Mr. Emerson was the first really accredited *civil* engineer to become a governor. It is evident, from Mr. Bacon's reminder, that in the West the step from state engineer to governor is fairly common.—EDITOR.]

Renewals and Life of Railway Ties

Sir—The article by Mr. MacLean, of the U. S. Forest Products Laboratory, on "Percentage Renewals and Average Life of Railway Ties," in *Engineering News-Record* of Aug. 26, p. 336, gives the railway maintenance engineer an accurate method of checking his tie renewals for the current year and forecasting the renewals for succeding years. Mr. MacLean not only verifies but amplifies the principle well established by Mable Thorn in 1918. The renewal curve indicating the relation between renewals and the average life of ties has proved a useful instrument for gaging with reasonable accuracy the number of ties that are due for renewal each year. It is shown that the law of probability operates in determining the renewals required each year. This is the same law that has had its chief practical application in insurance. By its use the life expectancy of man is so accurately determined that the insurance companies offer long odds on the bet that the man will live to a certain age. That these companies play a winning game is evidenced by their remarkable prosperity.

With reasonably accurate records of tie renewals for past years, by the use of the tie renewal curves and charts, the required renewals for any year may be computed and may be safely used as a guide in fixing the tie allotment for the year. The writer's experience bears out this statement. During the past eleven years he has used 26,056,602 ties in renewals. The number of ties required, figured by use of the curve, is 26,171,808. The actual renewals therefore fell short of the computed renewals by 115,206 ties, or less than 0.5 per cent. This is quite a remarkable corroboration. Its value is the greater as it represents renewals over some 10,000 miles of track, subjected to the widest variations of traffic and maintenance conditions, and traversing a territory varying in physical characteristics from the heavy grades and curvature of mountain regions to the low grades and straight alignment of prairie country.

Like all theoretical computations, its appeal to the practical man is not convincing, at least at first sight. He cannot understand how the number of ties he should renew the coming year can, with accuracy, be computed in a distant office by one who has not even seen his track. As he does not understand it, he is against it. But when he understands that it is not the individual tie that is designated, but the average per mile over his division, district or section, and when he sees how closely his actual requirements correspond to the computation, his interest is awakened and he falls in step with the march of progress.

There are, of course, instances of wide difference between the actual and the computed requirements. In such instances it is usually found that some local condition of an extraordinary nature is responsible, such as heavy mechanical wear, destruction of ties by derailments, excessive adzing and gaging on sharp curves, inadequate or excessive renewals in previous years. It will be found that these instances should have little effect on the general result, particularly on the larger railroads where the renewals involve large numbers of ties. The restriction of renewals in years of depression, when it is necessary to curtail expenditures, may throw the curve askew for a period, but it will be ultimately restored to true form by correspondingly heavy renewals in following years. The Forest Products Laboratory engineers are to be congratulated on the result of their work in giving us so reliable a means of gaging tie renewals and the probable service life we should obtain from ties. The methods they have formulated are of great practical value to the railway maintenance engineers.

Baltimore, Md., Oct. 26, 1926 EARL STIMSON, Chief, Engineer of Maintenance, Baltimore & Ohio R.R.

More Rights for Pedestrians

Sir—In your issue of Oct. 21 in an editorial headed "Futile Jaywalking," you refer to the "coming experiment in Washington, where it is proposed to have a probationary period during which pedestrian traffic violators will be warned and admonished. Thereafter the regulations will be enforced by arrest."

I am looking for the outcome of this experiment with some interest, because the simple fact is that there is never a minute when a pedestrian has the right-of-way if an automobile driver wishes to use it—as illustrated by a recent personal experience.

I waited on the corner until the signal started traffic moving east and west. Then I continued to wait while seven automobiles came around the corner and went south. Then, going as rapidly as I could, I managed to get to the middle of the street before the signal was changed again. Then I had to wait, with street cars moving a foot or so from my back and automobiles rushing along within a foot or so of my face until the signal was again changed when I managed to reach the opposite sidewalk.

I do not know whether the fact that the traffic director here was formerly an officer of an automobile association has anything to do with it or not, but the only attention paid to pedestrians by the traffic department in Washington is to bawl them out as jaywalkers, hand them pink cards of admonition and threaten them with arrest a little later for obstructing traffic, when anyone with half an eye can see that a pedestrian must walk through traffic or never go off the block on which he is located.

If things get much worse, it may be necessary for those who, either by choice or necessity walk instead of ride in motor cars, to organize an "S. O. S." Club—the "S. O. S." having reference not only to the danger which threatens us whenever we try to cross a street but also to the S(awed) O(ff) S(hotguns), to which we may have to resort in defense of our inalienable right to "life, liberty and the pursuit of happiness."

Why should there not be a time when pedestrians can cross a street without the likelihood of being killed or injured by an automobile coming from any direction whatever?

Washington, D. C. Oct. 22, 1926. S. A. THOMPSON, Secretary, National Rivers and Harbors Congress.

[Mr. Thompson's implication is that jaywalking is necessary if a pedestrian is to get across the street. The right-hand turn for motor traffic does of course impede the pedestrian even after the signals permit him to cross and is a source of danger and delay. Nothing in the editorial disavows this fact. It is, however, stated that few jay-walkers save any time. Pedestrian control should get a larger number of people across the street in less time and will speed up motor traffic. In addition the injury hazard will be reduced.—EDITOR.]

Theoretical Losses in Intersecting Pipe Lines

Sir—In your issue of Sept. 9, 1926, p. 437, there are two letters on the Theoretical Energy Losses in Intersecting Pipe Lines, one by J. C. Stevens, who contributed an original article on the subject in your issue of July 22, 1926, p. 140, and one by Prof. H. A. Thomas. It is interesting to note that these gentlemen are in slight disagreement, and the writer wishes to add to the confusion by disagreeing in certain respects with both. Perhaps when all our views are written down, we may be able to reach a solution to this perplexing problem.

The original article by Mr. Stevens is not at hand, but it is believed, from memory, that the equations deduced were based upon the law of the conservation of linear momentum. This law is universal and is precise. It requires no "experimental coefficients."

The underlying principles are illustrated in the accompanying figure. A given flow of water is assumed to be passing from A toward B and another from C into the main pipe. The momentum in any direction of any group of water particles after they pass the junction, as at B, is exactly the same as the momentum of the same particles in the specified direction before they reach the junction, except as altered by *external* forces. The combined momentums of the streams, A and C, in any direction, cannot be changed without making an equal change in the momentum of some other body, in the case contemplated, the earth or other supporting structure. *The momentum cannot be changed by eddies.* This is one of the most elementary and best established laws of physics.

If the lateral pipe is at right angles to the main, the flow at C has no velocity and, consequently, no momentum, in the direction A to B. Therefore the momentum of the combined streams at B, in the direction A to B, must be the same as the momentum in the same direction of the single stream at A, except as altered by *external* forces. There are no exceptions to this statement, and it is in no sense approximate.

If the main pipe is cylindrical, and neglecting friction, it may be tentatively assumed that the only force available for changing momentum between A and B, in the direction of the axis of the main pipe, is the change in pressure across the section of the main. This leads to the conclusion that the hydrostatic pressure, plus momentum (see *Engineering News-Record*, Nov. 25, 1920, p. 1034) at A, must equal the same function at B, as neither the axial pressure nor the axial momentum at C has a component in the direction A to B. Taking Q, V, g and P to represent respectively flow, velocity, acceleration of gravity and total pressure across pipe, and using subscripts to denote location, as shown in the figure, this relation may be expressed mathematically as follows:

$$\frac{Q_1}{g} V_1 + P_1 = \frac{Q_1 + Q_2}{g} V_3 + P_3 \qquad (1)$$

This reduces to:

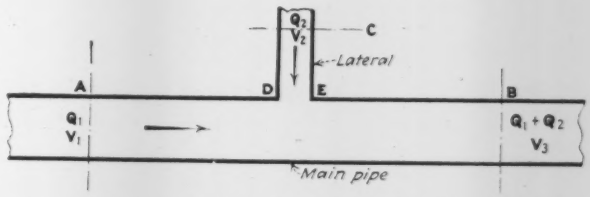
$$P_1 - P_3 = \frac{Q_2}{ga} (Q_1 + Q_2) \qquad (2)$$

where a is the uniform area of the main pipe.

If the assumption as to available external forces is correct, and if V_1 and V_3 represent actual *average* velocities, taken particle by particle, equation 1 is *rigidly* true. If the assumption is not true the equation is without proof. Equation 2 contains an approximation due to the substitution of the usual mean velocity for the actual average velocity, as above defined. These two functions are equal only when the velocity is uniform throughout the cross-section. Equation 2 is applicable only between points where the velocity distribution is approximately uniform. However, it makes no difference what happens between the two points, provided that the reaction in the direction A to B against the walls of the pipe is not altered. In the writer's opinion the italicized clause in the discussion by Mr. Thomas (*Engineering News-Record*, Sept. 9, 1926), has no relation to the particular problem under discussion.

It will be noted from equation 2 that neither the pressure nor the velocity in the lateral pipe theoretically affect the drop in pressure, except as they incidentally affect the volume of flow. If experiments show this to be incorrect, to an extent not reasonably chargeable to the approximations previously mentioned, then the premises that the pressure drop represents the only axial force is incorrect. It is useless to attribute any apparent deviation from the momentum equation directly to eddies. Internal impacts do not produce a reaction against the earth (or other supporting structure) and *cannot* affect the momentum. This statement is absolute, and cannot be scientifically contested. There is, perhaps, a possibility that violent eddies may alter the normal frictional resistance, thus indirectly slightly affecting the momentum.

With the arrangement shown in the accompanying figure it is possible that the normal pressures on the upstream and downstream sides of the lateral pipe, at D and E are unequal. If the flow in the lateral were outward, it would seem evident that there would be an excess force at E, due to impact. Such an unbalanced pressure would afford a means of reaction, and would fundamentally affect both equations 1 and 2. No theoretically correct equation for the phenomenon can be written without a knowledge of



the pressures at D and E. If any further experiments are attempted these pressures should be measured.

Mr. Stevens' formula for loss at a sudden enlargement may be logical, as he states, as an empirical formula, but there is believed to be no evidence that it is mathematically correct. It involves the *necessity* that the average pressure over the shoulder of the enlargement be equal to the pressure in the smaller pipe, which is by no means a self-evident condition. It is not intended to criticise the use of the formula for practical purposes, but only to question its scientific value.

Mr. Stevens states in his article: "So far as the momentum and energy equations applied to mean velocities and average pressures in the cross-section are concerned, there is no distinction between increasing and diminishing velocities." His attention is called to the phenomenon of the hydraulic jump, which is not reversible. A "standing drop" is physically impossible, because it involves an increase in mechanical energy. When a complete solution of the sudden enlargement problem, and the other cases discussed, is developed the direction of flow may similarly be found to be of importance.

JULIAN HINDS,
Resident Engineer, The J. G. White Engineering Corporation, S. en C.
Aguascalientes, Ags., Mexico,
Oct. 2, 1926.

Sir—I think Mr. Hinds and I are in complete agreement if our viewpoints can be made to coincide.

In my original article in your issue of July 22 the equations deduced were based on the law of the conservation of linear momentum. As Mr. Hinds states: "This law is universal and precise. It requires no 'experimental coefficients.'" To this I would add, when applied to particle velocities or to the average velocity of a group of particles. However when applied to mean velocity—a purely imaginary quantity—it certainly does require experimental coefficients. Mr. Hinds admits this when he says that his "equation 2 contains an approximation due to the substitution of the usual mean velocity for the actual average velocity."

Mr. Hinds' equation 2 contains a slight error, which however does not affect his statements regarding it. It should read

$$P_1 - P_3 = \frac{Q_2}{ga} (2Q_1 + Q_2) \qquad (2)$$

The above expression may also be obtained directly from equation 1 in my original article, by making $\theta_1 = o$ and $\theta_2 = 90$ deg. (see Fig. 1, *Engineering News-Record*, Sept. 9, p. 437) and substituting my expression for pressure (J — P)A for Mr. Hinds' expression for "total pressures across the pipe," viz., $P_1 - P_3$. Both expressions are obviously identical.

Equation 2, above, defines the pressure drop and is based

on the law of the conservation of linear momentum *applied to mean velocities*, not to particle or average velocities. The momentum so applied is certainly affected by eddies because eddies cause the mean velocity to depart widely from the average velocity. In practical hydraulics it is impossible to apply the momentum formula to average velocities; we must apply it to mean velocities, hence the necessity for experimental coefficients.

Experimental coefficients, however, mentioned in my reply to Professor Thomas' discussion (*Engineering News-Record*, Sept. 9, p. 437) are not applied to the pressure drop but to the loss of energy. Determining the pressure drop is only the first step in finding an expression for energy losses. These losses are due to the eddies caused as a result of a change in the shape of the conduit, the combining or separation of streams, obstructions, etc. Coefficients always have been and perhaps always will be necessary in the field of practical hydraulics. I know of no hydraulic formula deduced as a result of the application of known physical laws that does not require experimental coefficients for its practical application.

In conclusion I will take issue with Mr. Hinds' statement that the "hydraulic jump is not reversible." Perhaps this is true as the jump is ordinarily conceived—a foamy mass of rising water involving much eddying and energy losses. However Mr. Hinds himself has shown how a properly shaped hump (*Engineering News-Record*, Nov. 25, 1920, p. 1039, Fig. 9) may be placed in the bottom of a conduit that will cause the jump to occur smoothly and without appreciable energy loss. Such a rise in the water surface is a hydraulic jump just as truly as a rising foamy mass, and *it is reversible*. When reversed it is in effect a "standing drop" and there is no gain of energy. Water may flow in either direction over such a hump without appreciable energy loss.

When the complete solution of the sudden enlargement problem and the other cases discussed is developed, the direction of flow will undoubtedly be found to be of importance and the actual losses will be known only be means of carefully determined experimental coefficients.

Portland, Ore., Nov. 1, 1926. J. C. STEVENS, Consulting Engineer.

Sir—Mr. Hinds' disagreement with certain items in my criticism of Mr. Stevens' paper apparently arises from the fact that he has in mind not the general case on which this criticism was based, but the special case of finding the pressure drop in a straight pipe of uniform diameter joined at right angles by a smaller lateral. He is correct

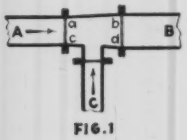


FIG. 1

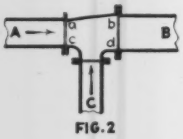


FIG. 2

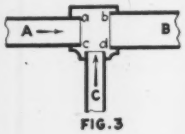


FIG. 3

in stating that in this special case the pressure drop in the main pipe can be computed approximately by a simple application of the principle of conservation of momentum, and independently of any consideration depending on the manner in which the streams mingle. This simple solution is possible because in the main pipe there are no surfaces of metal on which the water pressure can exert a pressure in the direction of flow, except the walls of the lateral near the junction.

The simplicity of this special case disappears when the attempt is made to compute the pressure drop in the water coming from the lateral by a method more accurate than that of making an arbitrary assumption that the pressures in the lateral and main upstream from the junction are equal. Any attempt at exact analysis by equating forces and changes of momentum in the direction parallel to the axis of the lateral is blocked by the existence of an unknown difference of pressure on opposite sides of the main pipe near the junction, this difference being influenced by the manner in which the streams mingle. If it were possible to locate some point in or near the junction where the pressures in the mingling streams had become equalized and the velocities equalized or known, and where no energy losses had occurred, we could determine the pressure changes upstream from this point by the principle of conservation of energy. The italicized clause in my letter to *Engineering News-Record* was simply intended to note that this method of analysis is also blocked, as there is no assurance that the energy loss does not begin before the pressures are equalized.

A more general case is shown in Fig. 1. Here the pressure drop from A to B cannot be computed by a simple equating of forces and momenta in the direction AB, since the reaction to the unknown water pressure on surface $acbd$ exerts a component in this direction. That something is involved in this case besides the over-all changes of momentum may be seen by varying the shape of surface $abcd$, as in Figs. 2 and 3. It is evident that the turbulence, and therefore the energy loss, will be greater in Fig. 3 than in Fig. 2. This consideration was what I had especially in mind when stating that in general the energy losses at a pipe-line intersection are affected by the manner in which the streams mingle, and that formulas which give the same energy loss for Figs. 1, 2, and 3 must be intrinsically in error.

HAROLD A. THOMAS,
Associate Professor of Civil Engineering,
Pittsburgh, Pa. Carnegie Institute of Technology.
Oct. 29, 1926.

Paying for Pavements

Sir—In the editorial in your Sept. 16 issue on Street Benefit Assessments, you state, "Roads and streets are public utilities and the public ought to pay for them en masse—at least until some more workable scheme can be developed than by charging in proportion to frontage on the highway." Traffic and its effect upon land values has been the subject of much controversy and Harland Bartholomew, city planning engineer, St. Louis, Mo., says, "Land values increase in proportion to the intensity and volume of traffic." My observation is that this is true in the majority of cases.

In my opinion, however, very few general conclusions can be drawn as to who receives the benefit from a public improvement. Each case must be studied by itself. For example, I believe it is unjust to levy an assessment for paving over both frontages on a corner lot in the residential district. But this rule does not hold in the business section.

It must be admitted that widening a street usually increases traffic on it. On p. 179 of the Report of the Chief Engineer for 1924 of the Board of Estimate and Apportionment of New York City the following statement is made, "It is possible that there may be a few exceptional cases where the widening of an existing street and its conversion into an important traffic thoroughfare or a boulevard will involve no special benefit upon the abutting property, although the Committee cannot recall a single instance of this kind."

I agree with you that we must develop some scheme more workable than merely limiting an assessment to abutting property. We must actually appraise the benefit to each property, whether it does or does not abut upon the improvement. In my own work I have appraised benefits on as many as 700 lots for a street opening only 1,000 ft. in length.

RAYMOND E. DUFF.
Cleveland, Ohio,
Oct. 30, 1926.

Serial Number on Fire Hydrants Would Help Water-Works Men

Sir—Three times in my experience I have had trouble getting repairs for fire hydrants in not being able to identify the particular lot of hydrants having only the manufacturer's name and address. I am suggesting that the specifications for fire hydrant as now prepared by the various associations be extended to include a clause reading about as follows: "All hydrants must be marked with a serial number on the barrel between and above the hose nozzles, the figures to be not less than ⅜ in. high and to be on a raised section of the barrel for easy finding." Hydrants are frequently found needing immediate repairs and it would be a very simple matter to order a part for hydrant No. ..... rather than look up records to identify the date, etc., and then maybe have it wrong.

SAMUEL P. BAIRD,
Managing Engineer, Construction Division,
Shelby, N. C., Cleveland Springs Co.
Oct. 29, 1926.

News of the Week

CURRENT EVENTS IN THE CIVIL ENGINEERING AND CONTRACTING FIELDS

Injunction Denied in Fight Against Prevailing Wage

Judge Levy, of the New York Supreme Court, Upholds New York City's New Subway Contracts

On Nov. 16, Judge Levy, of the New York Supreme Court, denied the motion for an injunction against the Board of Transportation of the city of New York in the matter of the new clauses in the contracts that the board has prepared for the subway construction of the city.

The controversy was outlined in *Engineering News-Record*, Oct. 21, 1926, p. 681. As stated there, it hinged on two clauses in these contracts. Points of issue in these clauses were that the requirement by the city (1) "that the wages to be paid upon the work contemplated shall not be less than the prevailing wage for a day's work in the same trade or occupation in the locality within the state," and the further provision of the city that for the purposes of this contract "the locality within the state shall be understood to be the City of New York"; and (2) "that the arbitration law of the State of New York shall be invoked in case of any controversy as to wages."

Substance of Opinion

Judge Levy, in a long decision, ruled in effect as follows: First, that a construction contract with a municipality requiring the contractor to pay the prevailing rate of wages in the locality is not illegal because of uncertainty as to the meaning of the terms "prevailing" and "locality"; second, that Section 220 of the labor law in so far as it requires contractors engaged in public work to pay the prevailing rate of wages in the locality is constitutional; third, the rules for determining the prevailing wage rate as embodied in the contract are practical working rules to aid the contractor and are proper and within the reasonable intent of the statute, and the arbitration clause for determining any controversy under such rule is likewise proper; fourth, the possibility that criminal prosecution for violations of the statute may be barred through uncertainty by reason of lack of precision in the definition of the offense does not dispense with the necessity of incorporating the provisions of the statutes within the contract; and, fifth, that the Rapid Transit Act, Section 37, Subdivision 2, authorizes the Board of Transportation to alter, modify or amend a proposed contract even after statutory public hearings as in its discretion it deems proper.

The justice, therefore, dismissed the complaint on the ground that it does not state facts sufficient to constitute a cause of action.

In the long decision, the judge did not take cognizance of any suggestion that the workers on the subways are not of a distinctive class for which a "prevailing wage" in the other parts of the city may be established. From the context of his decision, it is apparent that he believes that the prevailing wage is the full unit rate in the locality and that if 40 per cent of the men in any trade are unionized, their wages are to be considered the prevailing rate of wages and binding on public contracts.

It is announced that the decision will be appealed by the petitioners.

Engineering Fifty Years Ago

From *Engineering News*, November, 1876

AT THE recent convention of the Oriental Congress at Marseilles, Mons. De Lesseps, alluding to the submarine tunnel between France and England, and the creation of a sea in the desert of Sahara, by the influx of Mediterranean waters, spoke of the projected grand Central Asia line of railway to unite Europe and Asia by running to Peichauer in Anglo-India. He said that the scheme had received the approval of the Russian Emperor, and that the preparatory surveys would soon be completed. The railway outpost from Europe is now Orembourg, upon the Oural, in Asiatic Russia, and the line in question will reach Peichauer by way of Samarcand. Between this latter point and Orembourg there are numerous large towns, notably Tashkend, with a population of 150,000, but between Samarcand and Peichauer the country is very sparsely settled until Indoukouch, the ancient Indian Caucasus, is reached. The work is stupendous, but offers far fewer engineering difficulties than were required for cutting the Isthmus of Suez. This work required the invention of new instruments.

Upper Roadway for Susquehanna River Bridge

The Neeld Construction Co., Pittsburgh, has been awarded a contract by the Maryland State Roads Commission, Baltimore, to build an upper roadway and make other changes in the Havre de Grace-Perryville bridge over the Susquehanna River. The company's bid was $237,730 and the work is to be finished within a year. The changes will include the rebuilding of the draw and the installation of an upper deck to facilitate vehicular traffic. Work is to start at once and it is said that there will be no interference with traffic while it is under way.

Power Commission Issues Annual Report

Six Years' Licenses Total 3,900,000 Hp. —Lack of Personnel Hinders Action on Projects

Water power plants with a combined capacity of 3,900,000 hp., either in operation or under construction, have received licenses from the Federal Power Commission since its organization in July, 1920, according to the annual report of the commission. In that time the commission has received 726 power applications, 523 of which were for major projects. Of the latter number, 250 have been cancelled or withdrawn, leaving 273 in active status, with a capacity in proposed installation of 24,750,000 horsepower.

Commission Lacks Personnel

Since its organization the commission has been handicapped by a lack of personnel through inadequate appropriation for its operations. Except for changes in individuals, the commission has today only two more people on its staff than it had on the force temporarily supplied to it by the Departments of War, Interior and Agriculture when first organized. In the meantime, its appropriations have been reduced from $100,000, made available in 1921, to $33,400 for the current fiscal year. This has been done in spite of the fact that the commission has turned into the treasury in fees monies in excess of the total cost of its own staff and of those assigned to it by other departments. Due to the rapid increase in such receipts, the commission estimates that for the fiscal year 1927 it will turn over to the treasury $230,000, or 50 per cent in excess of the entire cost of administering the act for that year. A number of power projects which are still waiting the commission's action would now be under way, thereby bringing into the government increased revenue and adding to the available power resources of the country, had the commission been able to employ a larger staff. A total of 136 major applications, with a combined installation of 14,695,000 hp. still awaits the commission's action.

For the first time this year the commission exercised the authority granted to it under the federal water power act to regulate the issuance of securities by corporations taking out licenses under this act. This action came about through the peculiar circumstances surrounding the Conowingo development on the Susquehanna River in Maryland. In this case the pool above the dam will be in both Maryland and Pennsylvania, and the power which is to be developed in Maryland is to be transmitted into Pennsylvania for consumption. Moreover, certain features of the charter of the Philadelphia Electric Co., the company backing the project, made

(*Continued on p. 887*)

Why Ashokan Reservoir Storage Was Low

J. Waldo Smith Reports Charges of Heavy Leakage Were Groundless—Berkey Endorses Report

In a report made by J. Waldo Smith to Mayor Walker of New York City at the request of the latter, charges of leakage as the cause of low water in the Ashokan storage reservoir of the Catskill acqueduct system made in the New York *Herald-Tribune* of Oct. 25, are declared to be groundless. This declaration is endorse by Dr. Charles P. Berkey, professor of geology at Columbia University, to whom Mr. Smith gives credit of assistance.

In essence, Mr. Smith presents the same general reasons for the low stage of water in the Ashokan reversoir as were given in *Engineering News-Record*, Oct. 28, 1926, p. 719, in the form of a statement from W. W. Brush, deputy chief engineer, Department of Water Supply, under whom the operation of the Ashokan reservoir and Catskill aqueduct have been since their completion. That is, lowness was due to drawing from the reservoir much larger quantities than entered it during the past season, the object being to lessen the draft upon the Croton and other sources of supply in order to save pumping and also to give the people of New York the best of the available sources of supply.

GEOLOGICAL CONSIDERATIONS

Taking up first Professor Berkey's report and giving the gist of it so far as the geological considerations are concerned:

"After making such an examination, one is obliged to conclude that the behavior at the present time at Ashokan is absolutely normal. There is no doubt whatever about the watertightness of the reservoir and the efficiency of the dam. The geologic conditions both beneath the reservoir and on its margins on every side, including the dam and its foundations, are fully understood. Nothing was encountered during construction and nothing has happened since that time to change in any respect the conclusions reached in the original studies, on the basis of which the location was selected."

At the beginning of the report Mr. Smith points out that "In general, there is seepage from every reservoir which has ever been constructed, and there will be seepage from those constructed in the future," but adds that "such seepage is inappreciable in quantity and impossible of location or correction; indeed, it is absolutely negligible."

As proof of tightness, Mr. Smith states that from Sept. 30, 1925, to Sept. 30, 1926, all the water entering the reservoir, which averaged 175,000 m.g.d., "is accounted for by the flow into the aqueduct, all of which was used in the city." As to the assertion of the *Herald-Tribune* that large quantities of water were flowing down a separate cliff below the Ashokan land form the Ashokan reservoir, Mr. Smith points out that this must necessarily be the case always, the flow increasing progressively downward because there are 150 sq.mi. of drainage area below the dam which contributes substantially at the same rate as does the 257 sq.mi. above the dam to the reservoir.

The original estimate for the yield of Esopus Creek, on which the Ashokan reservoir is located, and of Schoharie Creek being diverted to the Ashokan by the recently completed Gilboa dam, was 250 m.g.d. from each, but the actual records from 1905 to 1925 show that each can safely furnish over 300 m.g.d. although "there may be a series of dry years in the future which would reduce this quantity." The Catskill Aqueduct is estimated to carry not less than 500 m.g.d., but will carry 650 m.g.d., operating results show.

From the time the Ashokan reservoir was put into permanent use on June 30, 1917, to Sept. 20, 1926, Mr. Smith states, it has supplied an average of 341 m.g.d., which is "an extraordinarily large quantity from a drainage area of 257 sq.mi." [meaning from Esopus Creek] while since the Schoharie Reservoir was put into service, although only partly completed, from Feb. 9, 1924, to Oct. 1, 1926, it has supplied an average of 171 m.g.d., which is estimated to be 57 per cent of the quantity it would have furnished if it had been fully completed."

Continuing, Mr. Smith says that "The Catskill is the cheapest and the best quality of water of any part of New York's water system" and that it is "all delivered into New York by gravity without the expense of pumping." Consequently, the Department of Water Supply has used this source to "the fullest possible extent" and with "such skill that no water has been wasted over the spillway of the Ashokan reservoir during all the long period from June 30, 1917, to the present time.

Summing up, Mr. Smith says the principal reasons for the apparently low stage of the Ashokan reservoir are:

(1) Thirty per cent more water has been drawn from the reservoir than it was designed to give or that any one expected it could continuously supply. (2) Two consecutive years, 1925 and 1926, have been drier than any other two consecutive years in the 20-year record, but they can be considered only moderately dry. (3) Because of continuous excessive draft during previous years, the reservoir was at a low level at the beginning of the season and the situation was further aggravated by lack of accumulated snow during the winter or of heavy rains during the spring and summer.

In conclusion, Mr. Smith points out that "Such conditions, or worse, may occur at any time in the future," and adds that "It is safe to say that there have been no droughts so great but that we may some time have greater." He therefore urges upon Mayor Walker and the city authorities the importance of acting without delay upon the two reports now before the Board of Estimate and Apportionment of New York City, one urging the development of an additional water supply from sources between the Hudson River and the Connecticut and Massachusetts lines, north of the Croton drainage area (see *Engineering News-Record*, Oct. 21, 1926, p. 670) and also the recommendations of the report which has been before the board for some two years urging a construction of a deep tunnel from Hillview reservoir, north of the New York City line, through Manhattan and to the Borough of Brooklyn.

Nine Bids Received for Building Coolidge Dam

Nine bids, the lowest of them being for $2,268,565, and the highest being $3,005,295, were opened Nov. 15 at the office of the U. S. Indian Service, Los Angeles, for the construction of the Coolidge dam on the San Carlos reclamation project near San Carlos, Arizona. The dam is to be of the multiple-dome type and was authorized for construction by Congress at a cost not to exceed $5,500,000.

Following are the nine bids:

Atkinson-Spicer, Los Angeles	$2,268,565
Utah Construction Co., San Francisco	2,451,329
W. A. Bechtel, San Francisco	2,465,156
Bent Bros., Los Angeles	2,489,573
Claude Fisher, Los Angeles	2,594,746
Allied Construction Co. and Ross Construction Co., Los Angeles	2,593,000
D. A. Foley Co., Los Angeles	2,613,563
A. Guthrie Co., Portland, Ore.	2,799,048
Macdonald & Kahn, San Francisco	3,005,295

Portland Cement Association Meets and Elects Officers

At the annual business meeting of the Portland Cement Association held in Chicago last week the following officers were elected: President, G. S. Brown, president, Alpha Portland Cement Co.; vice-president, Col. E. M. Young, president, Lehigh Portland Cement Co., and secretary-treasurer, John Boardman, president, Wyandotte Portland Cement Co.

Flood Control Project of North Canadian River Revived

A meeting of the state flood control commissioners of Texas, Oklahoma and New Mexico was held early in November at Amarillo, Tex., for discussion of joint action in the problem of flood control of the North Canadian River. As a result, an agreement to be submitted to the legislatures of the three states was drafted, and is now being revised for final approval by the commissioners. It is expected that this agreement will be submitted to the respective legislatures early in 1927. A general review of the situation was given in *Engineering News-Record* of March 11, 1926, p. 411.

A.S.T.M. to Meet Inland for First Time

The 1927 annual meeting of the American Society for Testing Materials will be held at French Lick Springs, Ind., June 20-24. This has been definitely decided by the executive committee of the society. This decision takes the convention to the Middle West for the first time in its history. The next annual meeting marks the 25th anniversary of the incorporation of the society and plans are being considered for a special commemoration of this event.

Third Tunnel Approach Contract Soon to Be Let

According to word circulated by the engineer in charge of construction, it is expected that early in December the New Jersey Highway Commission will authorize advertising for bids for work on Section 3 of the Route No. 1 extension. This is the third contract for the construction of the New Jersey approach to the Holland Vehicular Tunnel. The work will include the extension of the covered cut from Oakland Ave. to Collard St., the type of construction being similar to that now being carried out between Palisade Ave. and Oakland Ave., which is Section 2. There will also be a bridge carrying the highway over the Erie R.R. cut between Underwood Place and the Boulevard, a subway carrying it under the Boulevard, a double roadway and ramp between the Boulevard and Tonnele Ave., and miscellaneous work.

Railway to Gold Field Completed

The laying of steel on the branch line 44 miles in length from Taschereau (formerly O'Brien) on the Canadian National Ry. to Rouyn has been completed, opening up the copper-gold mining area of Northwestern Quebec. When the railroad has received the approval of the Board of Railway Commissioners its operation will be taken over by the C.N.R.

Asserts Seattle Lacks Power to Grant Toll Bridge Franchise

In a recent opinion, Corporation Counsel T. J. L. Kennedy of Seattle declares that the city is without authority to grant franchise for the erection of toll bridges across Lake Washington. Four companies have petitioned for a franchise to build a bridge over as many different routes.

Ashtabula Votes Against Making City Manager Elective

A proposal to have the city manager at Ashtabula, Ohio, elected by popular vote instead of being appointed by the city council, was defeated on Nov. 2 by a vote of 2,559 to 1,792. On the abandonment of proportional representation for the election of councilmen, the vote was 2,268 for, to 1,926 against.

Power Commission Issues Report

(*Continued from p. 885*)

it necessary for it to organize separate companies in Pennsylvania and Maryland for the development of the site. As the Maryland Public Service Commission has jurisdiction over the issuance of securities by public utility corporations in that state, and as the Pennsylvania Commission has no such authority, the Federal Power Commission, after discussing the matter with the state commissions, determined to exercise its powers over such securities, and subsequently required certain changes to be made in the financial structure as originally proposed.

New Record in Tunnel Drifting

During the month of October in driving the new eight-mile Cascade Tunnel for the Great Northern Ry., in the state of Washington, A. Guthrie & Co., Inc., established a new world's record for drifting, progressing 1,157 ft. through solid granite with a drift 8x9 ft. in cross-section, working one face only. Previous figures on this work were included in *Engineering News-Record*, Oct. 7, 1926, p. 594.

Council of Engineer Registration Boards Holds Convention

The seventh annual convention of the National Council of State Boards of Engineering Examiners was held in Philadelphia on Nov. 15 and 16. This conference was attended by delegates from the following states which are members of the council: Arkansas, Colorado, Florida, Indiana, Iowa, Louisiana, Michigan, Minnesota, North Carolina, South Carolina, Virginia and West Virginia. Arizona, Idaho, Oregon, South Dakota, Tennessee and Wyoming are also members of the Council but were unable to send representatives. The chairmen of the Pennsylvania and New Jersey Boards were present as unofficial representatives. The seven provinces of Canada having engineering registration were represented by a special delegate and American Engineering Council also sent a representative.

The following officers were elected for the ensuing year: President, Paul Doty of St. Paul, Minn., chairman of the Minnesota Board of Registration for Architects and Engineers; vice-president, Elmer E. Barnard of Lynchburg, Va., member of the Virginia Board for Examination of Engineers and Architects; secretary and treasurer, T. Keith Legaré of Columbia, S. C., secretary and member of the South Carolina Board of Engineering Examiners. The next convention will be held in Asheville, N. C. in November, 1927.

The secretary's report stated that the membership of the National Council now consists of the registration boards of eighteen states. Only three states having registration laws for professional engineers are not members of the Council, these being New York, New Jersey and Pennsylvania. Hawaii also provides for registration of professional engineers and Illinois requires the registration of structural engineers. California and New Mexico require examination and registration of land surveyors. Reports were read from a number of states which have pending legislation providing for registration.

The committee appointed to compile a suggested form of registration law for engineers made a tentative report and was continued until next year. A committee was appointed to consider amendments to the constitution to provide for changes suggested by some of the boards. This committee will report at the next convention. The committee on Classification of Engineering Colleges submitted a tentative list of recognized engineering schools.

A round-table discussion was conducted and various subjects considered, including methods of procedure in the examination and registration of engineers. It was decided that national reciprocity certificates would only be issued to registered engineers by the board of the state in which the applicant maintains his legal residence. Reports from the various boards showed that reciprocity is of comparatively little importance and hereafter the council will give most of its attention to other matters pertaining to registration. At the annual banquet Prof. P. H. Daggett of the University of North Carolina, retiring president of the council, delivered an address on "Engineering Education and it's bearing on the professional Status of the Engineer."

California to Hold Examination for Bridge Engineer

The California Highway Commission will receive applications until Nov. 30 for examination for bridge engineer, Grade 6. The applicants will be examined at Sacramento, San Francisco or Los Angeles. Applicants must have an education equivalent to graduation with a degree from an institution of recognized standing with major work in engineering, preferably structural engineering, together with eight years of general engineering experience, including four years in the direction or performance of important bridge design and construction or equivalent structural work, two years of which must have been in responsible charge of bridge engineering for a highway system comparable to that of the state of California. In the absence of the required education, at least four years of additional engineering experience will be required.

The examination will be held to fill the vacancy caused by the death of Harlan D. Miller who died Oct. 20. (See *Engineering News-Record*, Oct. 28, p. 723).

Bids Being Taken on Reclamation Canal on Kittitas Project

Sealed proposals will be received at the office of the Bureau of Reclamation, Ellensburg, Wash., until 10 a.m., Dec. 28 for the construction of approximately 10 miles of the Kittitas main canal, Division No. 2, and Tucker Creek siphon. The work is located near Easton and Cle Elum, Wash., on the Northern Pacific Ry. and the Chicago, Milwaukee and St. Paul Ry. The principal items and the approximate quantities involved are as follows: 1,500,000 cu.yd. of canal excavation, 46,000 cu.yd. of structure excavation, 40,000 cu.yd. of backfill, 12,800 cu-yd. of concrete canal lining or 159,000 sq.yd. of gunite canal liining, 6,300 cu.yd. of concrete in structures, the placing of 1,910,000 lb. of reinforcing steel, the laying of 36,000 lin.ft. of drain pipe, and the erecting of 73 m.b.m. woodwork, and 53,000 lb. of structural steel.

Elaborate Exhibit Is Feature at Welding Society Meeting

Special Correspondence

An exhibition of welding and equipment therefor was the most prominent feature of the annual fall meeting of the American Welding Society held at Buffalo, Nov. 16-19. More than 80 exhibits representing the industry of every section of the United States and including also two from England were on display, occupying the entire floor of the Broadway auditorium. The structural welding items included several full-size roof trusses and welded plate girders that had gone through ultimate load tests. An airplane fuselage of high-carbon steel and an aluminum automobile body both fully welded attracted much attention. Much new equipment was shown and in a number of booths welding was demonstrated during the entire week.

Technical sessions of the society dealt with structural welding, railway welding, welding in a gaseous atmosphere and instruction in welding in technical colleges. The latter subject attracted the attendance of many college faculty members. At the structural welding session papers were presented by H. H. Moss (Linde Air Products Co.), describing destruction tests of 40-ft. gas-welded roof trusses recently carried out (see *Engineering News-Record*, May 20, p. 826) and by A. M. Candy (Westinghouse Electric & Manufacturing Co.) reporting the comparative tests of arc-welded and riveted plate girders and various forms of structural joints which were made at Carnegie Institute of Technology three months ago (*Engineering News-Record*, Oct. 21, p. 660), and which supplied data used in the design of the welded factory building frame now under construction for the Westinghouse company at Sharon, Pa.

An organization meeting of the society's new research committee on structural steel welding was held. J. H. Edwards, assistant chief engineer of the American Bridge Co., is chairman. Fabricating and engineering interests are represented in the membership of the committee also by L. Allen (McClintic-Marshall), G. A. Caldwell (Mississippi Valley Structural Steel Co.), C. S. Davis, E. H. Ewertz (Bethlehem Shipbuilding Corporation), Prof. P. Gillespie, F. T. Llewellyn (Carnegie Steel Co.), L. H. Miller (American Institute of Steel Construction), J. W. Owens (Newport News Shipbuilding and Drydock Co.), S. C. Weiskopf, and Aubrey Weymouth (Post & McCord).

A large program of tests is projected by the committee. Detail plans will be worked out on the basis of subcommittee reports on existing data and scope of work, standard nomenclature, type of tests and procedure control.

Supreme Court Upholds Zoning

City zoning was upheld by the United States Supreme Court on Nov. 22 in the case of the Amber Realty Co. against the village of Euclid, Ohio. The court upheld the prohibition of business buildings in a district zoned for residences only.

WASHINGTON NOTES

AT THE request of those who take issue with the findings of the special board of engineers, of which Gen. Herbert Deakyne is chairman, a hearing will be conducted Dec. 1 before the Board of Engineers for Rivers and Harbors in Washington at which the report on the Lakes-to-Hudson Waterway will be discussed.

Portions of the report are made available to those who expect to appear at the hearing. The report itself is not to be made public until after its presentation to the House committee on Rivers and Harbors. It is understood that the report as revised emphasizes even more than the original study that the cost of the waterway would exceed greatly any possible benefits.

The new study also includes an estimate for a depth of 30 ft. The first report deals with depths of 20 and 25 ft. None will be surprised if that estimate exceeds $500,000,000 without taking into consideration the large expenditures which then would have to be made in deepening the channels and harbors of the Great Lakes and also the Hudson and the Welland Canal.

AN OPPORTUNITY is to be extended Dec. 3 for all those interested in the development of the Missouri River, between Kansas City and Pierre, S. D., to express their views on the project. The Board of Engineers for Rivers and Harbors will conduct a formal hearing in Washington on that date during which those concerned may present any opinions they may wish to bring to the attention of the board.

THE report of the Joint Board of Engineers on the St. Lawrence River has been completed and placed in the hands of Commerce Secretary Hoover who is the chairman of the President's advisory commission charged with a comprehensive study of the entire project. As this is written the release date has not been agreed upon with the Canadian government. The full report, which is understood to be voluminous, will be made public, however, in the near future.

The members of the American Section of the Joint Board are: Maj. Gen. Edgar Jadwin, the Chief of Engineers; Col. William Kelly and Lieut.-Col. George B. Pillsbury. The Canadian members are: D. W. McLachlan, O. Lefebvre and Gen. C. H. Mitchell.

THE lease of the government's 60,000-kw. steam plant at Muscle Shoals has been extended until Nov. 17, 1927. This is the fifth consecutive year that the Secretary of War has leased this plant to the Alabama Power Co. Its output has been fed into the southern superpower system. The government has received $1,250,000 in rental for the plant.

JURISDICTION over the proposed project of H. A. Spalding and associates on the headwaters of the Cumberland and Tennessee Rivers has been assumed by the Federal Power Commission. It is proposed to construct dams in the Obed River near the mouth of Clear Creek; in the Big South Fork of the Cumberland near the mouth of Pine Creek and in the Obey River six miles above Boon, Tenn. While the Chief of Engineers reports that the dams will not impede navigation, he points out that the construction of storage reservoirs on these headwaters might affect navigation adversely. For that reason it is felt that the project should go forward under the terms of the Water Power Act.

WHEN the Federal Power Commission met Nov. 17 to consider the applications of the Ozarks Hydro Electric Co. and the White River Power Co. for rights on the White River in Arkansas, a postponement was asked by each company. It is understood that negotiations looking to the settlement of the conflicting applications are in progress.

Cities Studied in $100,000,000 Federal Building Plan

More than nine hundred cities throughout the country have been given consideration in the nation-wide survey just completed by postal and treasury officials in the effort to determine which ones shall be selected as locations for new federal buildings under the $100,000,000 appropriation provided by the last Congress for that purpose. In addition to compiling records of the needs of these cities many of the larger ones have been visited personally. Because of the huge mass of information obtained during the survey it is estimated that considerable time will elapse before decisions will be made as to locations of prospective buildings, except in a few cities where dire needs make special action necessary.

Investigations have been made at Pittsburgh, Pa., and tentative plans drawn for a major mail-handling unit there. The building, as projected, will be 140x856 ft., providing approximately 250,000 sq.ft. for postal purposes, 140,000 sq.ft. for railroad tracks, and an entire basement floor for handling mail in bulk. The building will have a storage capacity for 42 mail cars and a tunnel connection with the Union Depot is contemplated. Another major project investigated concerns Philadelphia, Pa. The two projects will cost at least $15,000,000, and both buildings should be constructed prior to 1930.

A similar special survey has been conducted in New York City and recommendations made for the erection of two large units, providing in the aggregate approximately 1,200,000 sq.ft. of floor space. Both buildings would have railroad track facilities and a total loading-platform space for motor trucks of approximately 1,700 lin.ft. These two buildings, together with necessary land area, it is estimated, would cost between $20,000,000 and $25,000,000 for postal purposes only. In Chicago, a site has been advertised for and offers received for the erection of a new general post office building. The offers under consideration involve ground areas around 300 by 800 ft.

Large Expenditure on Paper Mill in Manitoba

In the construction of Manitoba's first big paper mill, and the townsite at Pine Falls, the Manitoba Pulp and Paper Co. will have expended $4,170,000 before the end of the year. In addition to this the project has meant the expenditure of $1,016,000 by the Manitoba Power Co. and its parent company, the Winnipeg Electric Co., for transmission of electric power from Great Falls. The power company has also invested $750,000 in extensions and installations, and in co-operation with the pulp and paper company is preparing to make still further improvements totaling several millions of dollars. The Canadian National Rys. has also spent $141,976 in providing railway facilities for the paper company. The paper plant will have a capacity of 100 tons per day and is expected to start operating very soon.

School for Filter Operators

In co-operation with the state university, the sanitary engineering division of the West Virginia Health Department held its second annual short school for filter operators and water-works superintendents at Charleston, W. Va., Nov. 12 and 13. The sessions were concerned principally with lectures and demonstrations by university professors on chemical, industrial and biological aspects of water supplies; practical discussions by consulting engineers and experts on special subjects of interest to water-works superintendents; and a roundtable discussion which concerned certain aspects of stream pollution and a clinic on chlorine disinfection apparatus with special reference to overcoming difficulties arising in practice.

Water-Borne Typhoid Damages Awarded Against Albany

Damages to the amount of $3,000 against the city of Albany, N. Y., for typhoid fever alleged to have been caused by the pollution of the city water supply in 1924, have been awarded by a jury in favor of John Weisner and son; $2,000 to the father and $1,000 to the son, the latter having been the typhoid victim. An earlier trial resulted in disagreement. The city may appeal. Of some 200 cases of typhoid in the spring of 1924, says New York State *Health News*, notice of suit in behalf of 13 have been filed within the required period.

Illinois Engineers' Joint Meeting

At the annual meeting of the Illinois Society of Engineers, to be held at Springfield on Jan. 25 to 27, a joint session will be held with the Illinois section of the American Water Works Association. The program of the engineers' society provides for meetings of its sections as follows: Jan. 25, drainage, surveying and city planning, and the electrical, mechanical and mining sections; Jan. 26, paving and sewerage sections; Jan. 27, water-works section (joint meeting.)

Engineering Societies

Calendar

Annual Meetings

HIGHWAY RESEARCH BOARD, OF NATIONAL RESEARCH COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Dec. 2 and 3, 1926.

AMERICAN ROAD BUILDERS ASSOCIATION, New York City; Annual Convention and Road Show, Chicago, Ill., Jan. 10-14, 1927.

AMERICAN ENGINEERING COUNCIL, Washington, D. C.; Annual Meeting, Washington, D. C., Jan. 12-15, 1927.

AMERICAN SOCIETY OF CIVIL ENGINEERS, New York City; Annual Meeting, New York City, Jan. 19-21, 1927.

ASSOCIATED GENERAL CONTRACTORS, Washington, D. C.; Annual Convention, Asheville, N. C., Jan. 24-28, 1927.

ENGINEERING INSTITUTE OF CANADA, Montreal; Annual Meeting, Quebec, Feb. 15-17, 1927.

AMERICAN CONCRETE INSTITUTE, Detroit, Mich.; Annual Meeting, Chicago, Ill., Feb. 22-24, 1927.

The Engineers Club of Minneapolis, at its meeting on Nov. 15, had the yards and terminals committee of the American Railway Engineering Association as its guest. After the dinner, an address as to the work and purposes of the Association was given by J. E. Armstrong, assistant engineer of the Canadian Pacific Ry. A paper on "The 8-mile Cascade Tunnel," now being driven for the Great Northern Ry., was read by J. V. Baxter, vice-president of A. Guthrie & Co., the contractors for the enterprise.

The Engineers' Society of Milwaukee has elected officers for 1926-1927 as follows: President, Arthur C. Flory, manager of the steam-turbine department of the Allis-Chalmers Mfg. Co.; vice-president, Alex H. Luedicke; secretary, Robert Cramer. At the meeting on Nov. 17 an address on "Water Power Development" was given by Prof. Daniel W. Mead, University of Wisconsin.

Personal Notes

CHARLES W. STANIFORD, consulting engineer, New York City, has been appointed consulting engineer to the South Jersey Port Commission, effective Oct. 1; Mr. Staniford is also consulting engineer for the New Jersey State Board of Commerce and Navigation.

A. A. MATHEWS has been appointed chief engineer of the Denver & Salt Lake R.R., with headquarters at Denver, Colo., succeeding R. D. STEWART, who has been assigned to other duties because of ill health.

R. W. BARNES, construction engineer on the Louisiana and Texas lines of the Southern Pacific Ry., with headquarters at Houston, Tex., has been promoted to chief engineer, with the same headquarters, succeeding H. M. LULL, who is promoted to the position of assistant to the president. E. A. CRAFT, assistant to the chief engineer, with headquarters at Houston, has been promoted to engineer of maintenance-of-way, a newly created position, with the same headquarters.

E. B. HUBBARD, who has been on the engineering staff of the Hydro Electric Power Commission of Ontario for some time, has resigned. Mr. Hubbard has gone to California.

Obituary

FREDERICK A. MCCLURE, a pioneer municipal engineer in New England and for twenty-five years city engineer of Worcester, Mass., died in that city Nov. 18 at the age of 74 years. Mr. McClure was a native of Nashua, N. H. He helped to lay out the Boston, Barre & Gardner R.R. and a part of the Union Pacific R.R.; and he was one of a party of engineers that made the survey of the 43rd parallel, the boundary between Nebraska and North Dakota. Then turning to municipal service, he worked out many problems of sewerage, water supply and other municipal work. In 1920 he organized the McClure, Greene Engineering Co., a consulting firm which specializes in water and sewer design, paving, bridges, dams and hydro-electric developments.

PROF. JAMES F. KEMP, professor of geology at Columbia University since 1891, a geologist of note who had been often consulted for information for use in water supply surveys, died of a heart attack Nov. 17 as he was leaving Great Neck, Long Island, to go to Columbia University; he was 67 years of age. Professor Kemp was formerly a member of the United States and the New York State Geological Surveys, was well known in this country and abroad in connection with geological and mining and metallurgical work, a member of many scientific organizations and a past president of the Geological Society of America, the New York Academy of Science, and the American Association for the Advancement of Science.

S. J. RILEY, of Poplar Bluff, Mo., a bridge engineer, was fatally injured Nov. 17 when he fell from a bridge at Columbus, Miss. Mr. Riley was 32 years old. He was formerly connected with the firm of Riley & Bailey Construction Co., of St. Louis. A bridge he constructed at Greenville, Miss., has one of the longest drawbridge spans in the South.

RONALD TAYLOR, vice-chairman of the Apprenticeship Commission of the Building Trades Employers' Association, died Nov. 16 in New York City. Mr. Taylor was known for his service in connection with the apprentice work of the New York Building Congress. Mr. Taylor was born in Brooklyn in 1863 and first entered business with his father, later establishing himself the Ronald Taylor Paving Co., though after 1912 he maintained a supervisory interest in business.

Construction Equipment and Materials

A SECTION DEVOTED TO WHAT THE MANUFACTURER IS DOING FOR THE ENGINEER AND CONTRACTOR

Crushed Stone Convention to Be Held at Detroit in January

The tenth annual convention of the National Crushed Stone Association will be held at the Book-Cadillac Hotel, Detroit, on Jan. 17, 18, 19 and 20, 1927. A manufacturers' exhibit of equipment for the crushed stone industry is being arranged by the manufacturers' division of the association. Additional information concerning the convention and exhibit can be obtained from the offices of the association, 651 Earle Building, Washington, D. C.

Spain Authorizes Purchase of Road-Making Equipment

The Spanish government has authorized the immediate purchase of road rollers, tanks and tractors to the amount of 19,000,000 pesetas, (about $2,900,000 at present exchange) according to a cable to the Department of Commerce from Madrid. The public roads program of Spain provides for highway construction involving an expenditure of 55,000,000 pesetas ($8,360,000) and of bridges costing 4,000,000 pesetas ($608,000).

Equipment Distributors to Publish Quarterly Bulletin

It is the plan of the Associated Equipment Distributors in the near future to begin publishing a quarterly magazine or bulletin. Its purpose will be to further high standards in the distribution of equipment, and to aid in the co-operation between the manufacturers and the distributors. The next meeting of the association will be held at the Palmer House, Chicago, January 7 and 8, Friday and Saturday, immediately preceding the Road Show.

Business Notes

BUFFALO FORGE CO., Buffalo, N. Y., has appointed Leon E. Haynes assistant advertising manager.

POLLAK STEEL CO., Cincinnati, has opened a sales and engineering office in the Penobscot Building, Detroit, with B. G. Yalman as district sales representative, and W. R. Klinkicht as metallurgist.

W. D. M. ALLAN has been appointed manager of the cement products bureau of the Portland Cement Association, succeeding A. J. R. Curtis who becomes assistant to the general manager of the association. Mr. Allan recently served as office manager of the Illinois district office of the association. The bureau handles the activities of the association dealing with concrete masonry houses and structures of all kinds, stucco, lighting standards, cast stone, roofiing tile, etc.

CHAIN BELT CO., Milwaukee, Wis., has taken over the Stearns Conveyor Co. of Cleveland, Ohio, engineers and manufacturers of belt conveyors. The company will continue to operate as a separate corporation, with Earl D. Stearns as president. The acquisition of this company makes the sixth of a group of affiliated companies which now consists of the Chain Belt Co., Sivyer Steel Casting Co., Federal Malleable Co., Interstate Drop Forge Co., all of Milwaukee, the Nugent Steel Castings Co., Chicago, and the Stearns Conveyor Co., Cleveland.

UNITED STATES CAST IRON PIPE AND FOUNDRY CO., Burlington, N. J., announces that Ralph M. Shaw has been appointed a director of the company. Mr. Shaw is a partner in the firm of Winston, Strawn & Shaw of Chicago, and has been associated with the United States Cast Iron Pipe and Foundry Co. as general counsel since its organization.

WILLIAMS FORM CLAMP CO., INC., Chicago, Illinois, has appointed Cunningham-Ortmayer Company, Milwaukee, as its distributors in the Wisconsin territory.

ROLLWAY BEARING CO., INC., Syracuse, N. Y., announces the appointment of John Parker as New England representative. Mr. Parker spent 11 years with Brown & Sharpe Co. and more than 15 years with three manufacturers of heavy equipment where the experience gained will be particularly useful in applying the Rollway line of heavy-duty bearings to heavy equipment in the New England territory.

NATIONAL WATER MAIN CLEANING CO., New York, announces that William H. Thompson & Co., Inc., and John Leopold Brodie, of Buffalo, N. Y., are now representing it in the securing of water main cleaning business.

AMERICAN VITRIFIED PRODUCTS CO., Akron, Ohio, formerly American Sewer Pipe Co., announces the reorganization of its personnel, which was necessitated by the death of George R. Hill, president from 1908 to 1926. The following changes have been made: F. B. Theiss, formerly vice-president, becomes chairman of the board; D. M. Colwell, formerly secretary, has been selected as the new president; W. K. Hill and F. W. Walker have been appointed vice-presidents; H. C. Maurer, sales manager, was elected secretary; and W. G. Murray will continue to serve as treasurer of the company, which operates thirteen factories located in Ohio, Pennsylvania, West Virginia, Michigan and Indiana.

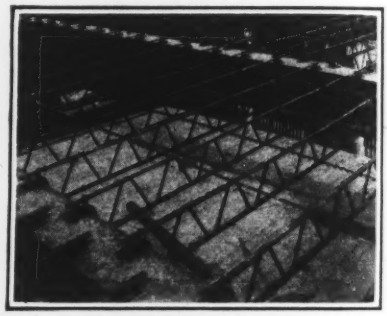
FRANK I. GINSBERG has resigned from Ginsberg-Penn Co., Inc., and the name will be changed to H. O. Penn Machinery Co., 18 E. 41st St., New York. The remaining personnel of the organization is kept intact.

JOHN H. WITHINGTON, New York district manager for A. Leschen & Sons Rope Co., St. Louis, died Thursday, October 21.

New Developments

Steel Joists Changed From Pratt to Warren Type Web System

Special semi-automatic machinery has been developed by the Rivet-Grip Steel Co., Cleveland, Ohio., for the production of the web members of its joists, in continuous units instead of on an individual basis as heretofore. In the old style of joists, the Pratt type of web system was used with individual pieces for both the vertical compression members and diagonal tension members. Both tension and compression



members were gripped individually at each end.

In the new joists, the web system is of the Warren type with a group of web members forming one continuous unit. The change has resulted in faster, cheaper and more accurate machine production of web members. The improvements are said to have resulted in a better appearance of the joists, considerably less deflection under working loads, greater rigidity, and some increase in ultimate strength.

Shovel of 6-Cu.Yd. Capacity Designed for Strip Mining Work

The new 200-B shovel recently developed by Bucyrus Co., Milwaukee, Wis., is built for fast digging on jobs where a smaller revolving shovel is not large enough and where an 8-yd. shovel is too large. The machine is convertible into a dragline. As a shovel, it is equipped with a box-girder boom and outside dipper handles. The boom is claimed to be much lighter than a split-boom of equal strength and

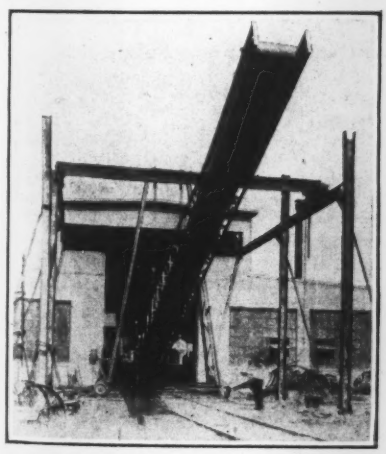
is especially adapted to withstand severe bending strains and torsional loads. Another advantage of this construction is claimed to be the requirement for less counterweights, which in turn enables the shovel to swing with

less effort. The shovel may be mounted either on four-wheel trucks or caterpillars. Both types of mounting have three point support which is claimed to reduce the load and wear on the trucks when the loaded dipper swings over the corner of the base.

Portable Belt Conveyor Handles 85 Cu.Yd. Concrete Per Hour

Part of the work on the Chicago Sanitary District's program is the construction of a long concrete retaining wall to be installed along the Illinois River close to the locks that are being built near Ottawa, Ill. There are over 100,000 cu.yd. of concrete to be placed and the Woods Bros. Construction Co., Lincoln, Neb., have elected to place it with a belt conveyor, which will be mounted on a four-wheel railway truck. The truck is equipped with a double adjustable winch for moving the equipment lengthwise of the forms.

The conveyor is 80 ft. long and is balanced at a point approximately 30 ft. out from the loading end. The overhang is therefore about 50 ft. and this discharge end is some 34 ft. above the ground level of the truck mounting. The capacity of the conveyor is 85 cu.yd. per hr. of mixed concrete. It is equipped

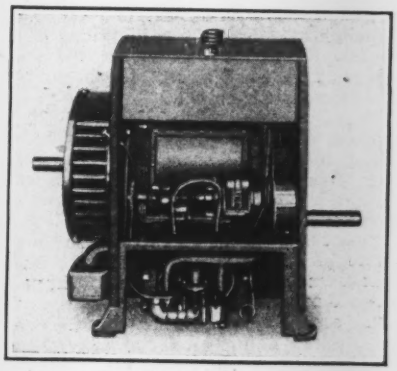


with a double reduced geared hoist for elevating or lowering it. The weight of the complete machine including mounting is slightly over 19,000 lb. The driving mechanism, which includes a 20-hp. motor with shafting, chain, boxes, etc., helps to counterbalance the long extension. The conveyor has been manufactured by the Northern Conveyor Mfg. Co., Janesville, Wis.

Use Has Proven Claims Made For Inverted-Cylinder Engines

When the two-cylinder, four-cycle water cooled gasoline power unit manufactured by The Cook Motor Co., Delaware, Ohio, and using an inverted cylinder with the crankshaft, connecting rods, etc., located on top of the main base casting was introduced some engineers are said to have been skeptical regarding the lurication of the unit. It was felt that the oil would bypass the pistons and carbon the cylinders. Operating results over a period of four years are claimed to have shown that lack of carboning is one of the main advantages of the engine.

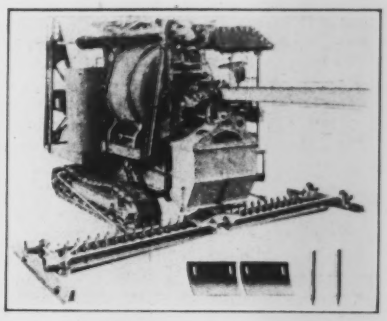
There have recently been some changes made in the unit, most important of which was the change in the design of the crank shaft. In doing this, the cylinder size was changed to a



4¼ in. bore by a 5-in. stroke, where before a 4½ in. stroke had been used. The new crank shaft is also designed so that the throws are opposite; that is, 180 deg. This feature is claimed to give smoother operation, practically eliminating vibration. At the present time this power unit is being used on the company's new line of equipment, which includes a concrete mixer, centrifugal pumping unit, force pumping unit and an electric lighting plant.

New Subgrade Planer Is Attached to Paver

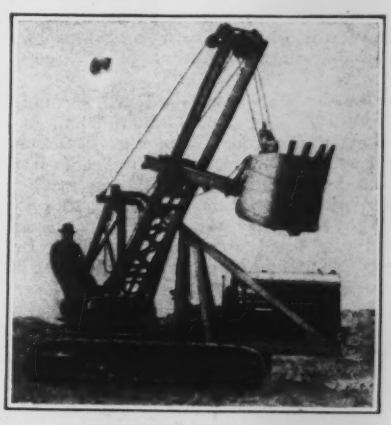
The new subgrade planer of the Koehring Co., Milwaukee, Wis., is operated by connecting it to the paver. By this method the subgrade is finished to the correct level just before placing the concrete. Wide wheels on each end of the planer ride on the road forms and support the frame. Scarifying teeth spaced about 12 in. are fastened to the frame ahead of the scraper blades so that the rough places are caught by the teeth and then brought down to smooth surface by the blades. Adjustments can be made so that the planer will leave the subgrade with any crown desired. If no center joint is used, the blades are adjusted to close up the opening at the center. It is claimed that in the average light soil of a subgrade, the planer will grade efficiently to a depth of 2 in. It is pointed out, however,



that it is not designed to work in hard clay or on old macadam road bed, or on one which has shale or rock embedded in large quantities.

Tractor Mounting for New ⅜-Yard Convertible Shovel

A new shovel, convertible to crane or backfill scraper, has recently been announced by the Bay City Dredge Works, Bay City, Mich. It is small and fast operating, relatively light and designed for general excavation, loading materials, backfilling, etc. The machine is built around the International McCormick-Deering tractor, which supplies the motive power and provides three propelling speeds, the fastest of which is 3½ m.p.h. The machine was designed by John W. Fairbanks. All of the operating machinery for the shovel is located on a revolving bull-wheel, above the machinery frame. The operator revolves with the machinery which swings through an arc of 270 deg. The machine is built throughout of steel using forged, heat treated and machine-cut gears and Timken roller bearings. The crawler treads are 9 feet long, with tread rollers enclosed as is the rest of the operating machinery, gears and bearings.



The shovel boom is 15 ft. long permitting the shovel to cut at a height of 17 ft. or dump at a height of 15 ft. A reversible and self-locking crowd, made up of a steel worm and a bronze gear running in oil is used. The machine weighs 9 tons.

New Publications

Truck Mounted Mixers—CHAIN BELT CO., Milwaukee, Wis., describes its new line of truck mounted mixers in a new bulletin. The bulletin features the kind of work a truck mounted machine can do and is entitled "Faster Mixing on a Faster Moving Basis."

Pumps—The DE LAVAL STEAM TURBINE CO., Trenton, N. J., has issued a leaflet describing the water works pumping station at Jackson, Mich. Turbine-driven centrifugal pumps have been installed in the old buildings, giving higher efficiencies and increased capacity.

Railway Locomotives. — INGERSOLL-RAND CO., New York City, has made available a booklet setting forth in narrative form the development of American railway motive power from 1826 to 1926, culminating in the oil-electric locomotive. The economy effected by this latest addition to railway motive power is the main thesis of the narrative.

Gasoline Engines — CLIMAX ENGINEERING CO., Clinton, Iowa, has issued a new bulletin describing its "R4U" and "R6U" engines for driving 750 and 1,000 gal. multi-stage centrifugal fire pumps. It is said that these engines are the only medium speed, heavy duty engines to be listed by the Underwriters' Laboratories. Basically the engine is the same that has been previously used as power for cranes, shovels, and similar equipment; a few changes have been made to meet Underwriter's requirements.

Concreting Machinery — RANSOME CONCRETE MACHINERY CO.'s bulletin No. 203 presents pictorially—so far as possible—the story of Ransome concrete chutes and equipment. The bulletin contains 68 pages and the photographs and data given should contain many valuable suggestions for plant layout.

Road Machinery — GALION IRON WORKS & MFG. CO., Galion, Ohio, has recently published four new bulletins, describing respectively its standard motor grader, its E-Z lift motor grader, its International motor roller, and its large 4-cylinder tandem roller. Each bulletin illustrates and describes the equipment and in each a tabular list of specifications is given.

Snow Plows—BAKER MFG. CO., Springfield, Ill., devotes a new 48-page catalog, numbered 235, to information on its snow plows for motor trucks and tractors. The booklet describes a large variety of both straight blade and V-type plows, either with or without wings. These are designed to operate with a variety of different makes of tractors and trucks. Many illustrations are given together with specifications for each model and a descriptive text.

Business Side of Construction

FACTS AND EVENTS THAT AFFECT COST AND VOLUME

This Week's Contracts—Week Ago—Same Week Last Year

THE money value of contracts reported in the present issue of *Engineering News-Record* is here compared with the figures for corresponding weeks. Minimum costs observed are: $15,000 for water-works and excavations; $25,000 for other public works; $40,000 for industrial and $150,000 for commercial, educational, religious and other buildings. Under the head of excavations are included drainage, irrigation, levee, river and harbor projects.

MONEY VALUE OF CONTRACTS LET—ENTIRE U. S.

Week Ending	Public Work	Private Work	Total Contracts
Nov. 25, 1926	$13,986,000	$19,147,000	$33,133,000
Nov. 18, 1926	19,264,000	36,814,000	56,078,000
Nov. 26, 1925	14,979,000	30,969,000	45,948,000
Heaviest Week			
1926, Mar. 11	13,029,000	73,613,000	86,642,000
1925, Sept. 3	16,215,000	69,424,000	85,639,000
January 1 to date			
	Public	Private	Total
1926	$995,467,000	$1,631,509,000	$2,626,976,000
1925	963,501,000	1,355,577,000	2,319,078,000

Foreign Projects of Interest to American Contractors

LOANS to the amount of $94,572,000 have been successfully floated in the United States, since the beginning of the year, for construction purposes in various parts of South America. The Republic of Panama also obtained $2,600,000 for railway extension and the construction of a wharf, as shown in the accompanying table.

There was also a stock issue of $20,000,000, exclusive of the projects here listed, by the International Telephone and Telegraph Co. for extension of foreign properties, chiefly in Cuba, Porto Rico and Mexico.

These jobs in which American bidders will probably compete, include the following: Streets, pavements, lighting, water-works, sewers, sanitation and other public works, banks, schools and other public buildings, aerial cableways, ports, wharves, railways, and agricultural improvements.

Since Nov. 1, three large South American projects have been proposed, namely: Hospital, Juin, Argentina, Province of Buenos Ayres, 490,000 pesos; a port as a terminal of the Western Railroad of Minas Geraes, Angra dos Reis, Brazil; construction of docks and warehouses, 520,000 cubic meters of dredging, Bahia, Brazil.

WHERE JOBS ARE LOCATED

Loans Floated in U. S. for Foreign Construction purposes During 1926.

Location	Amount	Rate of Interest	Term, Years	Parity	Purpose
URUGUAY Republic	$30,000,000	6	34	96½	Refunding certain existing debt, for sanitary works, ports, railways, agricultural promotion, schools and other public buildings.
PERU Republic	16,000,000	7½	30	100	Retiring certain indebtedness of Gov't., for public works, and, in discretion of Republic, for establishment of national agricultural bank.
ARGENTINA Prov. of Buenos Aires	14,472,000	7½	22	99	Reimbursing Prov. of Buenos Aires for sums expended for construction and acquisition of railway properties and also refunding $5,600,000 of Treasury obligations issued in U.S. for same purpose.
Prov. of Buenos Aires	10,600,000	7	26	96½	To provide for development of water-works and sanitation systems of Province.
BRAZIL State of Sao Paulo	7,500,000	7	30	96½	Additions, betterments, and extensions to water water supply and sewage systems of city of Sao Paulo.
City of Porto Alegre	4,000,000	7½	40	96	Sanitation works, street development, lighting, and paving.
COLOMBIA Dept. of Caldas	6,000,000	7½	20	95½	Extensions, additions and improvements of Caldas and Quindio Rys.; construction of aerial cableways; retirement of indebtedness previously incurred for railway construction, and for other productive purposes.
Dept. of Antioquia	6,000,000	7	20	91½	Construction of addition to Antioquia Ry. and betterment of existing lines of same railway.
PANAMA Republic	2,600,000	6½	35	103	Extension of Chiriqui R.R. and wharf.

The Sixty Biggest Jobs of the Year

Total Value $337,000,000—New York Contractors Get 30 Per Cent of Number Amounting to Over $91,000,000

A LARGE majority of the nation's sixty largest construction jobs awarded during the first thirty-eight weeks of 1926, were located in the Eastern half of the United States, as shown in the accompanying illustration.

Of the sixty projects here enumerated, eighteen, or 30 per cent, were let to New York contracting organizations. The money value of the contracts let to New York constructors was $91,402,749, or 27 per cent of the total for the sixty.

There were nineteen office buildings and five hotels among the awards and three each, of the following classes: Subways, pipe lines, power plants, warehouses, factories and theaters. Two bridges were included as were a like number of banks and hospitals.

A total of eighteen of these projects were located in the State of New York, while Illinois got nine, the next largest number.

Texas, California and Pennsylvania had five each, Michigan and New Jersey, three and Missouri, two.

The following states had one project apiece: Maryland, Kansas, Florida, Ohio, North Carolina, Connecticut, Colorado, Louisiana, Washington, Minnesota, Massachusetts, Vermont, Georgia, and Indiana. The Northeastern states had the heaviest volume, followed by the South and the Pacific Coast group, leaving the territory between the Mississippi River and the Rocky Mountains with the smallest amount in proportion.

LOCATION OF JOBS ON MAP

Owner, Contractor, Value, Etc., of Each of the Sixty Largest Projects

Nature of Job	Location	Contract Let By	Contractor	Amount
1. Power Plant	Conowingo, Md.	Maryland Public Service Commission	Stone & Webster, Boston, Mass.	$52,000,000
2. Office	New York, N. Y.	Bricken Construction Co.	Separate Contracts	10,000,000
3. Office	New York, N. Y.	New York Life Insurance Co.	Starrett Bros., New York City	10,000,000
4. Railroad	Kansas and Texas	Chicago, Rock Island & Pacific R.R. Co.	W. H. Dennison, Cushman, Ark.	10,000,000
5. Land Development	St. Augustine, Fla.	D. P. Davis Properties	Foundation Co., New York City	8,000,000 to 10,000,000
6. Office	New York, N. Y.	A. N. Adelson, Inc.	Shroder & Koppel, Inc., New York City	9,000,000
7. Depot	Cleveland, Ohio	Cleveland Union Terminal Co.	J. Gill & Sons, Cleveland, O.	8,000,000
8. Dam and Power Plant	Albermarle, N. C.	Carolina Power & Light Co.	Hardaway Contg. Co., Columbus, Ga.	8,000,000
9. Office	New York, N. Y.	H. I. Chanin	Separate Contracts	8,000,000
10. Arena	Jersey City, N. J.	Journal Square Gardens, Inc.	Thompson-Starrett, New York City	7,000,000
11. Subway	New York, N. Y.	City	Heyman & Goodman Co., Inc., N. Y. C.	6,641,678
12. Office	San Francisco, Calif.	E. H. Rollins & Sons and S.W. Coleman	Dinwiddie Const. Co., San Francisco, Calif.	6,500,000
13. Oil Pipe Line	Texas	Magnolia Petroleum Co.	Own forces	6,500,000
14. Office and stores	Chicago, Ill.	E. Jackson	Starrett & Dilks Co., Chicago, Ill.	6,100,000
15. Office	New York, N. Y.	M. Natanson	G. Richard Davis, New York City	6,000,000
16. Power Plant	Union, Pa.	West End Power Co.	Sanderson & Porter, New York City	6,000,000
17. Library	New Haven, Conn.	Yale University	Marc Eidlitz & Sons, New York City	6,000,000
18. Gas Pipe Line	Texas and Colorado	Lone Star Gas Co.	Own forces	6,000,000
19. Hotel	Houston, Tex.	R. S. Sterling	D. Hall, Houston, Tex.	6,000,000
20. Bridge Substructures (2)	Over Arthur Kill, New York and New Jersey	Port of New York Authority	P. J. Carlin Construction Co., New York City Triest Construction Co., New York City Frederick Snare Corp., New York City	1,386,100 946,750 3,260,580
21. Subway	New York, N. Y.	City	G. H. Flinn, New York City	5,020,000
22. Warehouse, Compress	Houston, Tex.	Manchester Terminal Corp.	Day labor	5,000,000
23. Automobile Plant	Pontiac, Mich.	General Motors Corp.	Austin Co., Detroit, Mich.	5,000,000
24. Administration Building	Massapequa, N. Y.	Deanville Estate, Inc.	T. C. Desmond & Co., Inc., New York City	4,500,000
25. Office and Store	Chicago, Ill.	Michigan Lakes Building Corp.	Paschen Bros., Chicago, Ill.	4,500,000
26. Office	Chicago, Ill.	Medical Arts Club	Thompson-Starrett Co., Chicago, Ill.	4,500,000
27. Bridge Superstructures (2)	Over Arthur Kill, New York and New Jersey	Port of New York Authority	McClintic Marshall Co., New York City Bethlehem Steel Co., New York City	2,599,150 1,888,269
28. Subway	New York, N. Y.	City	Moranti & Raymond, New York City	4,160,322
29. Hotel	Albany, N. Y.	Metropolitan Realty, Inc.	Separate Contracts	4,000,000
30. Theatre and Office	Pittsburgh, Pa.	Stanley Rowland Clark Corp.	W. L. Grange Const. Co., Pittsburgh, Pa.	4,000,000
31. Office and Loft	New York, N. Y.	A. Adelson	Shroder & Koppel, Inc., New York City	4,000,000
32. Bank and Office	New Orleans, La.	Canal Bank & Trust Co.	O. W. Gwin Constr. Co., New Orleans, La.	4,000,000
33. High School	Chicago, Ill.	City	Paschen Bros., Chicago, Ill.	4,000,000
34. Theatre and Office	Kansas City, Mo.	Loews, Inc.	Midland Invest. Co., Kansas City, Mo.	4,000,000
35. Hydro-Electric Developm't.	Chelan Falls, Wash.	Chelan Falls Electric Co.	Grant Smith & Co., Seattle, Wash.	4,000,000
36. Store and Office	Los Angeles, Calif.	Sun Realty Investment Co.	J. V. McNeil Co., Los Angeles, Calif.	4,000,000
37. Office and Garage	Chicago, Ill.	Building Construction Employers Assn.	J. Griffiths & Sons Co., Chicago, Ill.	4,000,000
38. Theatre and Office	Kansas City, Mo.	Midland Theatre and Realty Co.	Boaz-Kiel Constr. Co., St. Louis, Mo.	3,800,000
39. Hotel	Detroit, Mich.	Detroit Hotel Co.	Lundoff-Bicknell Co., Cleveland, Ohio.	3,500,000
40. Hotel	Vancouver, B. C.	Canadian National Ry.	E. J. Ryan Constr. Co., Vancouver, B. C.	3,500,000
41. City Hall	Los Angeles, Calif.	Board Public Works	C. J. Kuback Co. and others, Los Angeles, Cal.	3,085,000
42. Hospital	Rochester, Minn.	Mayo Clinic	G. Schwartz & Co., Rochester, Minn.	3,000,000
43. Hotel	Boston, Mass.	J. R. Whipple Corp.	G. A. Fuller Co., Boston, Mass.	3,000,000
44. Power House	Bellows Falls, Vt.	New England Power Co.	Power Construction & Engineering Corp., Worcester, Mass.	3,000,000
45. Factory	Port Ivory, N. Y.	Proctor & Gamble	J. W. Ferguson, Paterson, N. J.	3,000,000
46. Office	Chicago, Ill.	Wabash-Monroe Bldg. Corp.	G. A. Fuller Co., Chicago, Ill.	3,000,000
47. Warehouse	Atlanta, Ga.	Sears Roebuck & Co.	B. W. Construction Co., Chicago, Ill.	3,000,000
48. Warehouse	Detroit, Mich.	Coe Terminal Warehouse	Walbridge Aldinger Co., Detroit, Mich.	3,000,000
49. Office	San Francisco, Calif.	Hunter-Dulin & Co.	Separate Contracts	3,000,000
50. Office	San Francisco, Calif.	Hunter-Dulin & Co.	Lendgren-Swinerton, Inc., San Francisco, Cal.	3,000,000
51. Cement Plant	La Salle, Ill.	Central States Eng. Co.	Cowen Eng. Co., Chicago, Ill.	3,000,000
52. Bank	Albany, N. Y.	Home Savings Bank	J. Dyer, Albany, N. Y.	3,000,000
53. Oil Pipe Line	Illinois and Indiana	Roxana Petroleum Corp.	Day labor	3,000,000
54. Office	Chicago, Ill.	A. C. Mather	W. A. Illsey, Chicago, Ill.	3,000,000
55. Office	Philadelphia, Pa.	Providence Life Insurance Co.	Turner Constr. Co., Philadelphia, Pa.	3,000,000
56. Office	Philadelphia, Pa.	Philadelphia Electric Co.	J. N. Gill Co., Philadelphia, Pa.	3,000,000
57. Office	New York, N. Y.	American News Co.	Cauldwell-Wingate Co., New York City	3,000,000
58. Road Program	Pennsylvania	State Highway Department	Continental Cont'g Co., Baltimore, Md., and others	2,819,000
59. Loft	New York, N. Y.	Kymson Realty Co.	Separate contracts	2,800,000
60. Hospital	Northport, N. Y.	U. S. Veterans Bureau	A. Blair, Montgomery, Ala.	2,719,956
Total				$336,726,805

Weekly Construction Market

PRICES hold fairly steadily at last week's levels in the nine great industrial districts for which quotations are given in the accompanying table.

Recently the tendency has been downward and further slight declines may occur between now and the end of the year.

In the New York district, seven out of twelve price changes are declines, at the present time. While structural timbers remain firm, with increasing scarcity, there is a noticeable upward tendency in yellow pine and Douglas fir two-by-fours; No. 1 common boards, 1x6-in.; wire nails and linseed oil.

A very slight seasonal easing-off is apparent in common brick; portland cement; yellow pine flooring, 1x4-in.; crushed stone; window-glass; cast-iron pipe and wrought-steel pipe.

With the fuel market weakening, pig-iron demand is noticeably slower in the New York and Youngstown districts; Birmingham and Chicago, however, show no tendency to slacken. The effect of recent fluctuations in the fuel and iron markets has been negligible so far as finished steel is concerned. Steel demand is slow, with the exception of some recent active buying in steel plates and railway material.

The minimum quotation on any of the principal heavy-rolled steel products is still $1.90 per 100 lb., Pittsburgh mill; large tonnages of bars and shapes are $2 per 100 lb., while less-than-carload lots go at $2.10.

	New York	Atlanta	Dallas	Chicago	Minneapolis	Denver	San Francisco	Seattle	Montreal
Steel Products									
Structural shapes, 100 lb.	$3.34	$3.80	$4.15	$3.10	$3.35	$3.07½	$3.30	3.15	$3.75
Structural rivets, 100 lb.	4.20	3.80	4.75	3.50	3.75	4.65	5.00	4.00	5.50
Reinforcing bars, ¾ in. up, 100 lb.	3.24	2.80	3.38	2.60	2.87½	3.77½	2.95	3.10	2.50
Steel pipe, black, 2½ to 6 in. lap, discount	48%	54%	53.6%	51%	54.25%	41%	49.7@54.1%	45%	37.83
Cast-iron pipe, 6 in. and over, ton	51.60@52.60	45.25	54.00	48.20	53.00	64.00	50.00	55.00	—50.00
Concreting Material									
Cement without bags, bbl.	2.50@2.60	2.35	2.05	2.10	2.32	2.85	2.31	2.65	1.15
Gravel, ¾ in., cu.yd.	1.75	1.90	2.38	1.85	1.65	1.90	1.80	1.25	1.50
Sand, cu.yd.	1.00	1.60	2.00	1.65	1.25	1.00	1.40	1.25	1.25
Crushed stone, ¾ in., cu.yd.	1.94	2.50	2.83	1.87½	1.75	2.50	1.70	3.00	2.00
Miscellaneous									
Pine, 3x12 to 12x12, 20 ft. and under, M.ft.	62.00	34.00	56.00	40.50	38.75	34.75	27.00	25.00	50.00
Lime, finishing, hydrated, ton	18.20	23.50	19.00	20.00	25.50	24.00	25.50	24.00	21.00
Lime, common, lump, per bbl.	2.10@3.00	1.50	1.82	1.50	1.70	2.70	1.60	2.80	10.00
Common brick, delivered, 1,000	20.40@22.40	10.50	14.10	12.00	13.75	9@10	15.00	15.00	20.25
Hollow building tile, 4x12x12, per block	Not used	.0895	.112	.088	.076	.075	.....	.09	.10
Hollow partition tile 4x12x12, per block	.1027	.0895	.112	.088	.076	.075	.108	.09]	.08
Linseed oil, raw, 5 bbl. lots, per 7½-lb. gal.	.86¼	.99¾	1.10	—.84	—.92¼	1.07	1.01	1.12	1.05
Common Labor									
Common labor, union, hour	.90⅝	.30	.....	90	.....	.50@.55	.55	.62½	.....
Common labor, non-union, hour	.....	.25	.30@.50	82½	.45@.60	.40@.45	.50	.50	.30@.35

Explanation of Prices—Prices are to contractors in carload lots unless other quantities are specified. Increases or decreases from previous quotations are indicated by + or — signs. For steel pipe, the prevailing discount from list price is given; 45-5% means a discount of 45 and 5 per cent. L.c.l. is less than carload lots.

New York quotations delivered, except sand, gravel and crushed stone, alongside dock; common lump lime in 280-lb. bbl. net and hydrated lime, f.o.b. cars; tile "on trucks"; linseed oil and cast-iron pipe f.o.b. Reinforcing bars (billet steel) and shapes delivered to job in less-than-carload lots.

Labor — Cement and concrete laborers' rate, $1.06¼; building laborers, 90⅝c.

Chicago quotes hydrated lime in 50-lb. bags; common lump lime per 180-lb. net. Lumber, sand, gravel and stone f.o.b.; price on fir is quoted instead of pine. Reinforcing bars (billet steel) f.o.b. warehouse in carload lots; shapes, less-than-carload lots.

Minneapolis quotes on fir instead of pine. Brick, sand and hollow tile delivered. Cement on cars. Gravel and crushed stone quoted at pit. Bars (billet steel) at warehouse in carload lots; shapes, less-than-carload lots.

THIS limited price list is published weekly for the purpose of giving current prices on the principal construction materials, and of noting important price changes on the less important materials. Moreover, only the chief cities are quoted.

Valuable suggestions on costs of work can be had by noting actual biddings as reported in our Construction News section.

The first issue of each month carries complete quotations for all construction materials and for the important cities. The last complete list will be found in the issue of Nov. 4 the next on Dec. 2.

Denver quotes on fir instead of pine. Cement "on tracks"; gravel and sand at pit; stone on cars; lime, brick, hollow tile and lumber on job. Tile price is at warehouse. Linseed oil, delivered in wooden bbl. Common lump lime per 180-lb. net. Bars (billet steel) and shapes, l.c.l.

Atlanta quotes sand, stone and gravel per ton instead of cu.yd. Common lump lime per 180-lb. net. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Dallas quotes lime per 180-lb. bbl. Cement, cast-iron pipe and crushed stone f.o.b. cars, other materials delivered. Bars (billet steel) and shapes, l.c.l.

San Francisco quotes on Heath tile, size 5½ x 8 x 11½. Prices are all f.o.b. warehouses except C.-I. pipe, which is mill price plus freight to railway depot at any terminal. Common lump lime per 180-lb. net. Lumber prices are to dealers in yards at San Francisco, for No. 1 fir, common. Bars (billet steel) f.o.b. in carload lots; shapes, l.c.l.

Seattle quotes on Douglas fir (delivered) instead of pine. Lump finishing lime per 180-lb. net. Brick and hollow building tile delivered. Hydrated lime in paper sacks. Sand and gravel at bunkers. Bars (billet steel) and shapes, less-than-carload lots.

Montreal quotes on fir lumber. Sand, stone, gravel and lump lime per ton. Stone and tile are delivered; sand, gravel, lime and cement on siding; steel and pipe at warehouse. Hollow tile per ft. Cement price is in Canadian funds (the Canadian dollar stands at 100.187). Bag charge is 80c. per bbl. Discount of 10c. per bbl. for payment within 20 days from date of shipment. Steel pipe per 100 ft. net; 2½ in., $37.83. Bars (billet steel) carload lots; shapes, l.c.l.

Business Briefs

Call money quoted at 4½ per cent, Nov. 22; year ago, 4½ per cent.

Time loans: 60 to 90 days, 4⅝; 4 to 6 months, 4⅝@4¾ per cent.

Commercial paper: Best names, 4@6 mo., 4½; others, 4¾ per cent.

On Nov. 1, 1926

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E. N.-R. Construction Volume Index Number 244

For Explanation and Details of Indexes Since 1913 See the First Issue of Every Month